

Reference

FM 5-15

DEPARTMENT OF THE ARMY FIELD MANUAL

FIELD FORTIFICATIONS

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DEPARTMENT OF THE ARMY • AUGUST 1949



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FM 5-15

*This manual supersedes FM 5-15, 14 February 1944, including
C 1, 23 February 1945, and TB ENG 7, 4 February 1944*

FIELD
FORTIFICATIONS



DEPARTMENT OF THE ARMY • AUGUST 1949

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BY ORDER OF THE SECRETARY OF THE ARMY:

OFFICIAL:

J. LAWTON COLLINS

Chief of Staff, United States Army

EDWARD F. WITSELL

Major General

The Adjutant General

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CHAPTER I

INTRODUCTION

Section I. GENERAL

1. PURPOSE. a. This manual provides the latest information on hasty or expedient means of obtaining protected firing positions for weapons, and shelter for individuals and units, with a minimum expenditure of time and labor. Such hasty or expedient defensive works are known as field fortifications.

b. This manual is designed for use by all branches of the Army, in all climates and on all types of terrain.

2. SCOPE. a. This manual incorporates the best field fortification practices and techniques developed, tested, and proved in World War II. It also covers techniques improvised since that war. It includes detailed information on the construction of expedient intrenchments, emplacements, hasty shelters, entanglements, and obstacles, and describes the tools necessary for such construction. Included also are data on certain semipermanent works that may be constructed when time and materials permit and contact with the enemy is not imminent.

b. This manual also contains a discussion of barrier

tactics and methods of combining individual field fortifications to form a coordinated system.

3. USE OF FIELD FORTIFICATIONS. Field fortifications are defensive works constructed when preparing for an expected enemy attack, when consolidating a position before mounting an offensive, and when protecting against counterattack the ground taken from the enemy.

a. Although combat units primarily are concerned with the construction of fortifications, a knowledge of fortification techniques is essential to supporting and rear echelon troops. In modern warfare, these troops are as susceptible to enemy action as front-line units and, because they are so indispensable to front-line troops, their destruction or neutralization by enemy action may cause serious reverses to the friendly mission.

b. The decisions as to whether or not a position should be occupied and the degree of fortifications to construct are primarily tactical and beyond the scope of this manual.

4. CLASSIFICATION OF FORTIFICATIONS. The two general classes of fortifications are field fortifications and permanent fortifications.

a. **Field fortifications.** Field fortifications are those initially constructed when in contact with the enemy or when contact is imminent. They consist generally of clearing fields of fire, digging weapon emplacements and positions for personnel, laying antitank and anti-personnel mine fields and barbed-wire entanglements, strengthening natural obstacles, selecting command and observation posts, and providing camouflage (for cam-

ouflage technique see FM 5-20). It is this class of fortifications with which this manual is primarily concerned.

b. Permanent fortifications. Permanent fortifications are those constructed when out of contact with the enemy, or developed gradually from field fortifications. They include permanent and elaborate intrenchments; antitank ditches; obstacles of wood, concrete, or steel; improved weapons emplacements; elaborate barbed-wire entanglements; troop shelters which protect against artillery fire and weather; extensive signal communication systems; gasproofing of command posts and aid stations; and elaborate camouflage. See TM 5-310 for permanent fortifications.

Section II. ORGANIZATION AND PLANNING

5. ORGANIZATION OF THE GROUND. **a.** Organization of the ground is the strengthening of a defensive position by constructing field fortifications and camouflaging. The scope of this work is limited only by the time and facilities available. Protection is obtained by distributing defensive works in depth and width, adapting them to the terrain, concealing them, and building them of strong, adequate materials. Measures for increasing the effect of fire and for providing adequate signal communication (described in detail in FM 100-5) have first priority.

b. Immediately upon occupying a position, a unit strengthens its defenses by clearing fields of fire, by constructing shelters for individuals and emplacements for weapons, and by erecting obstacles. Measures for con-

concealment and camouflage (FM 5-20 series) are carried out along with construction tasks. The unit commander establishes priorities for these tasks, based on the tactical situation. The normal priority of work is stated in paragraph 6.

6. PRIORITY OF WORK. **a. Normal sequence.** The assignment of work priorities does not prevent simultaneous work on several tasks. After the general location of combat emplacements is determined, the normal priority of work is as follows:

- (1) Clearing fields of fire and removing objects that restrict observation.
- (2) Providing for adequate signal communication and observation systems.
- (3) Laying antitank mine fields and preparing important sites, such as bridges, for demolition.
- (4) Preparing individual shelters and weapons emplacements.
- (5) Preparing secondary demolitions and obstacles other than mine fields.
- (6) Improving routes for supply, evacuation, and movement of reserves.

b. Planning camouflage. Field works should be sited to permit their easy camouflage. Consideration of this factor initially will save much labor later in effecting good camouflage. The construction of dummy objects or positions and other deceptive devices, together with concealment or camouflage measures, is performed along with normal work. These dummy positions likewise require careful siting to insure that the over-all lay-out is effective.

7. CONSTRUCTION. The types of field fortifications described in this manual have proved their value in combat and have been selected primarily for practicability, simplicity, and ease of construction by unskilled troops. Most of them are adaptable to the use of explosives and power equipment in construction.

a. General troops. Field fortifications are constructed by the troops occupying the position, irrespective of their branch. For this reason, construction is kept as simple as practical consistent with the time, skills, equipment, and materials available. Modification of all defensive works to fit existing situations is common practice in combat. Whenever practical, full use is made of power tools, heavy equipment, and explosives to aid construction.

b. Special troops. In large-scale operations, corps, army, and general engineer units are assigned the heavier tasks and rear-area fortifications works. Engineers execute large-scale demolitions, create obstacle zones, construct field works requiring special equipment and training, make available engineer equipment and supplies, and furnish technical advice or assistance.

8. TOOLS. a. Intrenching tools. Tools normally used for hasty fortification work (fig. 1) are carried by the individual soldier in his pack. A standard distribution is prescribed within the squad and platoon to insure availability of a suitable number of each type tool. These may be supplemented by additional tools from intrenching equipment sets (see **b** below), or from engineer depots. In Arctic conditions of extreme cold and deep snow, the intrenching axe is essential to the individual

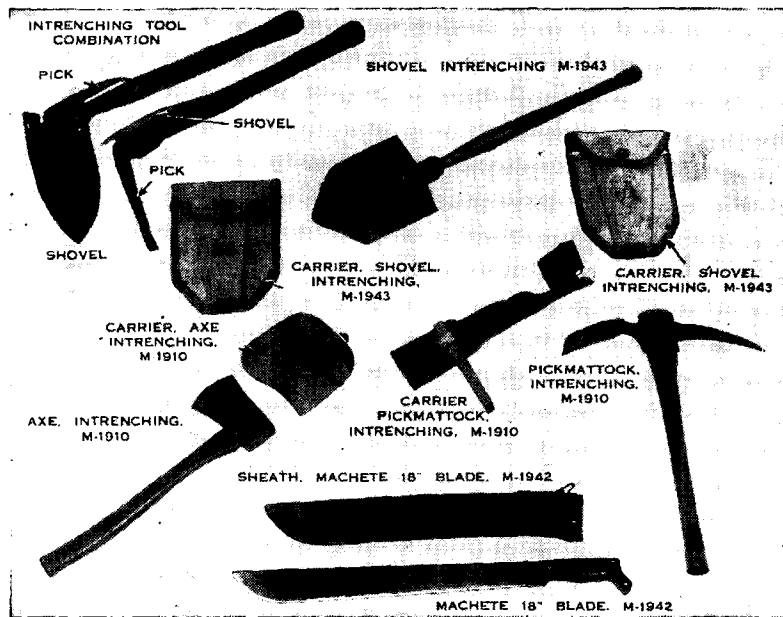


Figure 1. Intrenching tools carried by the individual soldier.

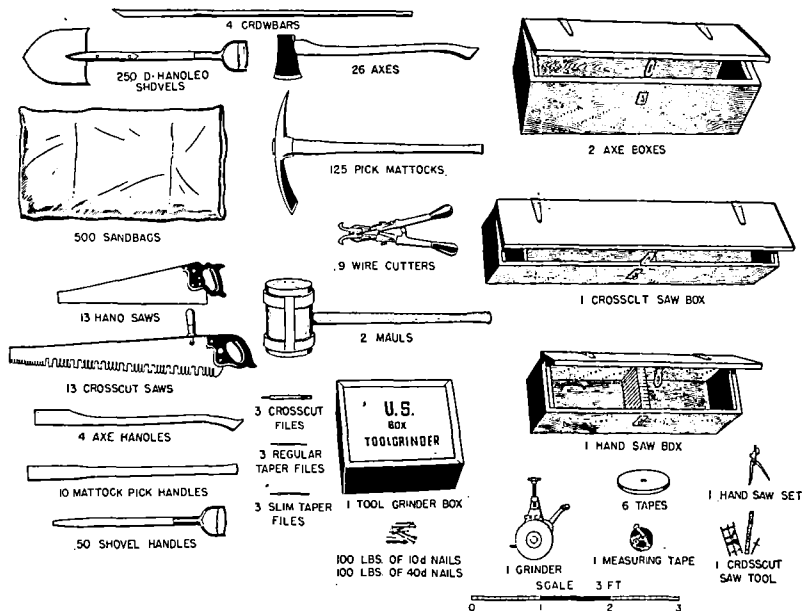


Figure 2. Tools carried in intrenching equipment set, No. 2, infantry.

soldier for preparing individual emplacements in the frozen ground.

b. Infantry intrenching sets. Infantry intrenching sets (fig. 2) consist of a balanced stock of field-fortification hand tools and materials supplied to infantry battalions as organic equipment. These tools, carried in a 2½-ton truck and 1-ton trailer, supplement the individual intrenching tools carried by the infantry soldier.

c. Supplementary tools. In addition to the hand tools shown in figures 1 and 2, use should be made of power tools and powered heavy equipment. For example, the winch on a truck may be used to pull saplings and brush; or a tankdozer may be used to excavate emplacements. Engineer depots normally stock tractors, bulldozers, and other grading, excavating, and earth-moving equipment; air compressors with many pneumatic power tools; and construction tools such as paving breakers, clay diggers, pneumatic drills and hammers, chain saws, and backfill tampers.

9. MATERIALS. a. Natural materials. Full use is made of all available natural materials when constructing and camouflaging individual shelters, hasty emplacements, and overhead cover. As a general rule, enough natural material can be found in an area to meet all requirements for constructing hasty or expedient fortifications. In Arctic country, snow and ice, if handled properly, can be used for this purpose (see pars. 47d and e, 85, 90, 91, and 92).

b. Other materials.

- (1) Manufactured materials such as pickets, barbed wire, lumber and materials for revet-

ting, camouflage, shelter, and concrete construction are supplied by engineer dumps. Antitank and antipersonnel mines are supplied by ordnance dumps in the same manner as ammunition.

- (2) Captured enemy supplies and shelled buildings are excellent sources of expedient construction material.

c. Explosives. Many fortification tasks are made easier and accomplished more quickly by using explosives or captured stocks of land mines, shells, and bombs. For further details on the use of explosives, see appendix I.

Section III. POSITION AND TERRAIN

10. DEFENSIVE AREAS. a. Siting positions.

- (1) A *defensive area* is any area assigned to a given unit to be protected from, and held against, enemy attack. A *defensive position* is any area occupied by troops in a system of mutually supporting emplacements or fortified tactical localities. All such positions must be planned and sited to take every advantage of the terrain to insure maximum effectiveness for the fire power to be employed.
- (a) Defensive positions do not follow a set pattern in lay-out or design but are sited to conform to the surrounding terrain features and immediate tactical requirements of the defensive area.
- (b) Next to proper siting for maximum effective delivery of fire power, the most im-

portant aspect in planning defensive areas is camouflage of each position.

- (2) The defensive strength of a fortification system depends upon the ability of individual emplacement to deliver continuous short-range flanking and supporting fire and to afford protection, relief, and adequate ammunition supply for the defending troops. The works are so placed as to be mutually supporting, yet spaced far enough apart that enemy artillery fire or bombs which hit or barely miss one installation will not hit others. All terrain should be covered effectively by observation and fire.
- (3) Fortifications are constructed for all-around defense of platoon or company defense areas. They may be combined into closely organized battalion defense areas or echeloned in width and depth.

b. Weapon emplacements.

- (1) Permanent works (treated fully in TM 5-310) are supplemented by field fortifications and alternate weapon emplacements. The fire mission of these positions includes protection of permanent position embrasures, communication routes, and defiladed areas. Field fortifications in a permanent defensive system allow troops to continue to fight when their permanent positions have been neutralized and provide firing positions for reserves in the counterattack.
- (2) Alternate positions are prepared for all wea-

pon emplacements except those for fixed guns. Positions exposed to direct enemy fire may be connected by crawl trenches, covered trenches, or well-camouflaged uncovered trenches.

II. LOCATING WORKS. a. Reconnaissance. Higher commanders, such as division corps, or army commanders, decide the location of the battle positions, the employment of the artillery, the assignment of defense sectors, the strength and location of the general reserve, the antimchanized defenses, and other security measures. Successive reconnaissances by lower commanders determine the distribution of small units and the location of their combat emplacements. Reconnaissance is as detailed as the situation permits. It includes a study of the principal routes of hostile attack and the terrain available for hostile observation. The officer on reconnaissance first identifies the area to be occupied and selects covered approaches to the area. Detailed reconnaissance determines key points of defense, avenues of enemy approach, natural obstacles, and obstacles which may have to be improved.

b. Terrain evaluation.

- (1) The character of the terrain has a decisive influence on the selection of positions. Natural obstacles such as river lines, swamps, and woods afford good protection against mechanized units, when covered by fire. This prevents the enemy from breaching the obstacles.
- (2) Prominent elevations and ridges outline the compartments of terrain and form the framework of the system of observation, command, and fire control. They determine directly the

location of observation posts and the positions of supporting weapon emplacements. Indirectly, they determine the location of defensive and assembly positions. For fundamental doctrines of defensive combat, see FM 100-5. For details of infantry defense, see FM 7-20 and FM 7-40.

c. Types of global terrain. There are six distinct types of terrain in which fortifications may have to be constructed in a global war. Table I provides a description of the characteristics of each type, the digging conditions, the natural camouflage at hand, and the local natural materials which may be available for construction of fortifications.

d. Obstacles.

- (1) *Natural and artificial.* Obstacles may be classified as natural or artificial. Natural obstacles are hills, rivers, woods, and marshes. Artificial obstacles consist of such devices as barbed wire, mines, and trip flares. Obstacles may be further classified as to the type of defense which they perform or assist.
- (2) *Tactical.* Artificial obstacles such as barbed wire, trip flares, and antipersonnel mines are used to prevent the enemy from delivering a surprise assault from positions close to defense areas. They are placed in such a manner that their removal or neutralization by the enemy can be prevented by rifle, machine-gun or antitank fire. Such obstacles are close enough to defense areas to allow adequate day or night surveillance and far enough away (100 yards) to prevent the enemy from lying be-

TABLE I. *Types of Global Terrain*

Terrain	Characteristics	Digging characteristics	Natural material available for construction	Camouflage available
Arctic	Mostly flat, barren, deep snow, frequent large areas of tundra or short vegetation; bordered by large areas of coniferous trees. Occasional barren, ice and snow-covered mountain ranges divided by glaciers.	Difficult digging. Deep snow over frozen ground. Explosives and power tools necessary for digging into ground.	On flat, barren ground, ice is only material available. For igloos and ice huts, scant vegetation provides insulation and matting.	Snow offers concealment but not cover unless tamped or frozen. Wooded areas afford natural camouflage.
Temperate ...	Gently rolling; patches of fields, woods, brush, and pasture land frequently crossed by streams and rivers.	Generally easy digging with hand tools.	Usually plenty of natural material available for all types of expedient construction work.	An abundance of natural camouflage and cover.
Desert	Flat, arid, sandy, or clay country with low, scrubby vegetation, usually bordered by mountains or rising ground to temperate terrain.	Easy digging with hand tools.	No material available for construction except for rocks and sand and occasional low bushes.	Occasional rocky outcroppings, scrub growth, washes, ravines, and gullies offer some cover and concealment.

Mountain	Mountain ranges are found in all climates. Those in Arctic regions are devoid of vegetation. Mountains in temperate and jungle terrain are well covered with foliage.	Difficult digging requiring the use of explosives and power tools.	In Arctic climates none but ice and rock. In other climates, wood is usually available.	Cover and concealment are more than adequate. However, the nature of the terrain tends to bunch the troops and restrict operations.
Jungle	Flat, gently rolling, hilly, and/or mountainous terrain covered with dense vegetation, sparsely vegetated areas, and occasional clearings. Thick heavy undergrowth under forest trees.	Numerous roots of trees and shrubs make digging more difficult than in temperate terrain.	Abundance of natural material for construction.	Natural camouflage better than in any other type terrain.
Swamps, marshes, water-logged ground.	Are found in jungle, temperate, and semi-Arctic terrain. They are isolated areas of low, flat, mushy, or partially inundated ground with scattered islands of vegetation and hard ground. Except when frozen over, they should be avoided whenever	Digging impossible except on larger islands where firm soil is usually only a few feet deep. Built-up emplacements are most practicable, such as sandbag parapets. possible because of the extreme difficulty in crossing.	Except for wooded areas, there is little natural material available.	Built-up emplacements as are necessary in this terrain are extremely hard to camouflage. Except in wooded areas, natural camouflage is limited.

yond the obstacle and effectively using hand grenades. Additional obstacles may be installed close to defense areas. For a further discussion of obstacles, see paragraphs 105 and 106.

e. Emplacements.

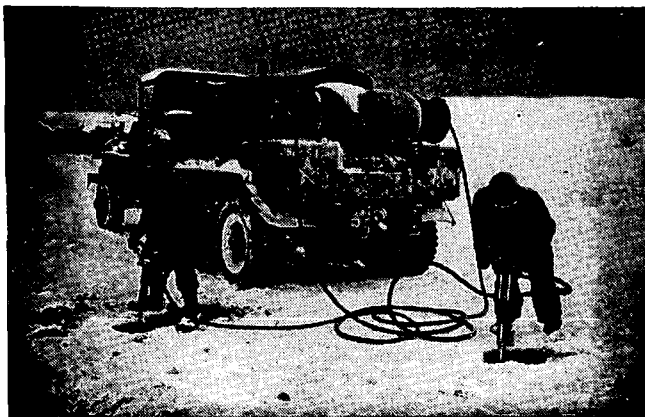
- (1) Emplacements are individual positions dug within the defense area and so placed to give adequate observation, protection, and concealment and to allow maximum fire power to be delivered on routes of enemy approach. Soil conditions within the defense area often determine the exact location of each emplacement, but not to the extent of reducing effective delivery of fire. These emplacements should be mutually supporting.
- (2) Primary, alternate, and supplementary emplacements are dug and concealed for the all-around protection of each defense area. Camouflaged connecting routes between positions are selected or constructed. As time permits, dummy works should be located realistically to mislead the enemy and disperse his fire.

t. Shelters. Shelters provide protection from inclement weather and enemy action. They are constructed or dug for troops, their weapons, and supplies. Since shelters are not fighting positions, they usually are located on reverse slopes of hills, in woods, ravines, or gullies, or in other natural low points of defilade. Hasty shelters normally are built by combat troops; deliberate shelters, by troops in support of front-line units.

Section IV. CONSTRUCTION

12. EXCAVATION. **a. Average ground.** Excavation usually is done by pick and shovel. The nature of the soil, tools available, condition and experience of men, presence of the enemy, amount of light, size of excavation, and weather conditions affect the rate of excavation. Because of these variables, precise data on the man-hours required to excavate all types of soil cannot be given. However, an average man, using standard-size tools can excavate between 20 and 30 cubic feet of average soil per hour. Table II gives estimates of man-hours required to excavate the various types of infantry-weapon emplacements in average soil.

b. Frozen ground. Construction of field fortifications in winter or in Arctic terrain presents numerous difficulties because of cold, frozen ground, ice, and snow. Since the soldier's capacity for work is lowered by extreme cold, power tools and explosives frequently are used but, in sub-Arctic weather, even these are unreliable as they often freeze. When it is impossible to dig in because of frozen ground, deep snow, or lack of time, cover above the ground level must be provided. Such cover is obtained by stacking cakes of frozen snow, ice blocks, logs, or sandbags to form walls which may be hardened by pouring water over them. Digging down as far as possible through loose snow or top crust provides the position with a low silhouette and affords maximum concealment. From late October to early March in Arctic regions the ground is generally too frozen to permit digging emplacements. The most practicable individual emplacements or shelters to construct under such conditions are snow holes or caves (pars. 90 and 91),



① Air hammers being used to prepare holes for explosives



② Blasting frozen earth



③ Bulldozer scoops out loosened earth

Figure 3. Preparing an emplacement in frozen ground.



④ Bottom of emplacement is leveled with hand tools

Figure 3. Preparing an emplacement in frozen ground—Continued.

igloos (par. 100), and icecrete fortifications (par. 19e). When these are not possible because of lack of time or unfavorable conditions, concealment is the only method of obtaining protection.

c. Hard ground.

- (1) To make digging easier, explosives are used to break up or loosen hard or frozen ground unless the tactical situation prohibits noise. Captured enemy mines and explosives should be used as much as possible for this purpose to conserve unit demolition supplies. Enemy mines which have been laid in the ground for some time or have been subjected to artillery fire are *not* employed because they may be highly sensitized and might, therefore, detonate with movement or rough handling. In general, such mines should be detonated or destroyed in place.

- (2) When using explosives, small charges may be

used to make holes for larger charges. Charges should be well tamped to insure the maximum breaking and loosening effect on the soil. See appendix I for detailed information on the use of explosives in preparing fortifications.

d. Mountainous terrain. Excavation in mountainous terrain usually is difficult because of rocky soil and because the use of explosives often is denied by the proximity of the enemy. However, mountainous country ordinarily has many natural positions such as caves, hollows, fissures, and rocky outcroppings which offer suitable cover and concealment. Existing positions can be strengthened by piles of rocks or empty ammunition boxes filled with rock. These may be secured with wire mesh to prevent injuries from flying particles. Sandbags filled with sand, snow, or other nonshattering material provide good protection against bullets and shell splinters. When ground conditions permit, positions dug laterally into the sides of mountainous or terraced terrain provide the best cover and concealment.

e. Flat waterlogged country.

- (1) Excavating in marshes, swamps, and the like is not feasible because subsurface water soon fills up the holes. Even in winter, marshy areas, unless subjected to extended periods of freezing weather, do not freeze more than 1 or 2 feet below the surface of the ground. To overcome this difficulty, positions are built up from ground level with sandbags, logs, and ammunition and ration boxes filled with soil, rocks, or packed snow. Dikes, river floodbanks, and other available high ground are

utilized for dug-in emplacements. The difficulty in moving heavy weapons and equipment over such ground usually restricts both offensive and defensive fire power in such areas to hand-carried weapons.

- (2) Some swamps are dotted with small islands of firm ground which can be developed into strong points. However, all built-up defensive works are difficult to conceal and should be avoided unless absolutely necessary.

13. CLEARING FIELDS OF FIRE. When on the offensive and in continual contact with the enemy, there is normally little opportunity to clear fields of fire. Advancing individual riflemen and weapons crews must select the best natural positions available, and ordinarily have time to clear only in the immediate vicinity of the weapon. However, in preparing *defensive* positions for expected contact with the enemy, suitable fields of fire are cleared in front of each intrenchment or emplacement. In clearing them, the following principles must be observed:

- a. Do not disclose position by excessive or careless clearing (fig. 4).

- b. In areas organized for close defense, start clearing near main line of resistance and work forward at least 100 yards.

- c. In all cases leave a thin natural screen of vegetation to hide defense positions (fig. 5).

- d. In sparsely wooded areas, remove the lower branches of large scattered trees. Occasionally it is desirable to remove entire trees which might be used as reference points for enemy fire.



ORIGINAL TERRAIN



WRONG - AFTER IMPROPER CLEARING



RIGHT - AFTER PROPER CLEARING

Figure 4. Clearing fields of fire.



① WRONG
(IN FRONT OF NATURAL SCREEN)



② RIGHT
(JUST BEHIND THIN NATURAL SCREEN)

Figure 5. Thin natural screen.

e. In heavy woods, complete clearing of the field of fire is neither possible nor desirable. Restrict work to thinning undergrowth and removing lower branches of

large trees. In addition, clear narrow lanes of fire for automatic weapons (fig. 6).

f. Remove or thin thick brush. It is never a suitable obstacle and obstructs the field of fire.

g. Mow grain crops and hay fields or, if ripe and dry, burn them if this will not disclose the position. Usually this is practicable only for a deliberate position organized prior to contact with the enemy.



① WRONG—TOO MUCH CLEARING, OEBRIS NOT REMOVED, ENEMY WILL AVOID



② RIGHT—ONLY UNDERBRUSH AND TREES DIRECTLY IN LINE OF FIRE REMOVED, ENEMY SURPRISED

Figure 6. Clearing lanes of fire.

h. Drag away cut brush to points where it will not furnish concealment to the enemy nor disclose the position.

i. Before clearing the fields of fire, make a careful estimate as to how much clearing can be done in the time available. This estimate often determines the nature and extent of the clearing to be undertaken, since a field of fire only partly cleared may afford the enemy better concealment and cover than the area in its natural state.

14. DISPOSAL OF SOIL. **a.** In average ground, excavated soil is much lighter in color and tone than surface soil and must be hidden carefully to prevent disclosure of the fortification (fig. 7). Soil may be disposed of as follows:

- (1) It may be used to form a parapet if the topsoil is carefully saved and used to cover the parapet. Turf, sod, leaves, or other litter from under nearby bushes or trees are used to make the parapet resemble its surroundings.
- (2) It may be removed and carefully hidden under trees or bushes or in ravines. Care must be taken to avoid revealing tracks.
- (3) It may be collected and used, partly camouflaged, to form parapets for dummy positions.

b. In winter or in Arctic terrain, mixed snow and earth from excavated emplacements must be covered with a layer of fresh snow to camouflage them.

15. DRAINAGE. Lack of proper drainage increases the maintenance work and the hardships of the troops occupying the fortifications. Drainage must be provided in the lay-out and construction of all works.



SPOIL BEING REMOVED CORRECTLY



SPOIL BEING CONCEALED CORRECTLY

Figure 7. Disposal of soil.

a. **Proper location.** Proper location limits the drainage problem but does not eliminate it. If possible, low points and drainage lines are avoided, and trenches are located on slopes (fig. 8). A slope of 1 percent causes all water to run to the lowest part of trench, from which

it can be drained easily. Slopes exceeding $2\frac{1}{2}$ percent cause erosion.

b. Surface and rain water. Surface and rain water can be excluded by using small ridges to deflect it into ditches (fig. 8) or flumes to carry it over the fortification.

c. Subsurface water. Subsurface water may be removed by using sumps or drainage ditches (fig. 8) run into natural drainage lines from lowpoints in intrenchments or emplacements. Sumps are located at low points and emptied by bailing, siphoning, or pumping. They should be a minimum of $1\frac{1}{2}$ feet square and 1 foot deep.

d. Thaw drainage. Special ditches must be dug to drain away the water which results from a thaw. Crawl trenches and tunnels must be built with enough gradient to drain off the water. Failure to observe these precautions results in the flooding of the excavation and in the caving in of the weakened and undercut walls.

16. REVETMENTS. A revetment is a retaining wall or facing for maintaining an earth slope at an angle steeper than its natural angle of repose. In loose or granular soil, measures must be taken to prevent crumbling of walls when the position is to be occupied for more than a few days. Decreasing the slope for this purpose also decreases protection afforded by the emplacement and makes concealment more difficult. Revetments require considerable labor and material, but reduce maintenance and insure stability of the earth slope. Earth walls in intrenchments and emplacements not only are subject to normal erosion processes and wear and tear of constant occupation, but also must withstand heavy earth

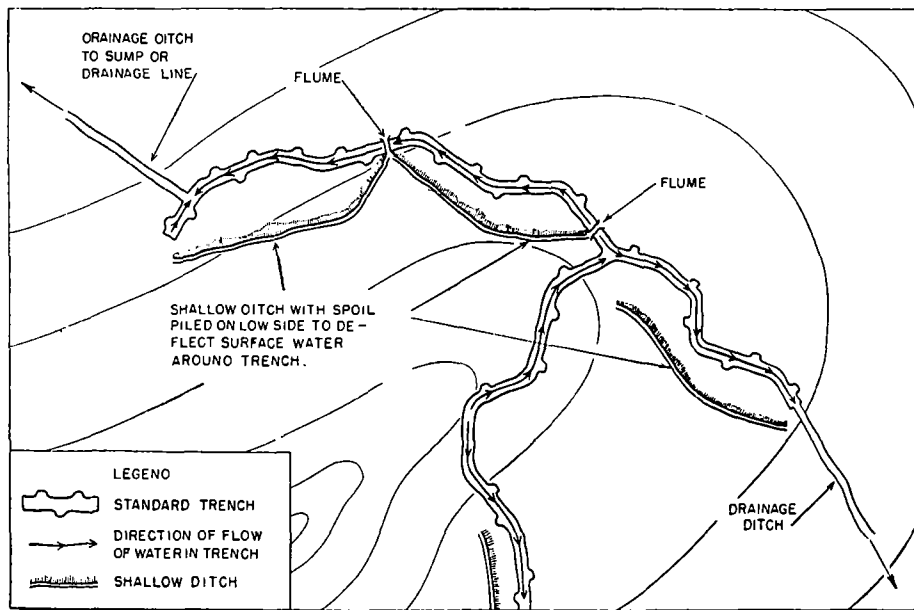


Figure 8. Trench properly located for drainage.

shock caused by explosion of bombs and artillery shells. There are two kinds of revetments, the retaining-wall type and the surface or facing type.

a. **Retaining-wall type.** This type is strong enough to retain a dirt wall without extra bracing or supports. Dimensions of the excavation must be increased to allow space for this type of revetment.

(1) *Sandbag revetments.* These are particularly useful for emergency work, for repairs, and on the interior slopes of earth parapets.

(a) The standard sandbag measures 14 by $26\frac{1}{4}$ inches when empty and has a string attached 3 inches from the top. When three-fourths full, the bag weighs from 40 to 75 pounds, depending upon the nature and moisture content of the filler. The average filled sandbag weighs about 65 pounds and occupies a space $4\frac{3}{4}$ by 10 by 19 inches. The following data are useful in estimating the number of sandbags required for revetting purposes:

1. If a single row of stretchers is used, as occasionally is done for small revetments, about 160 sandbags are required for each 100 square feet of surface to be revetted.
2. If alternate headers and stretchers are used, as is proper, about 320 sandbags are required for each 100 square feet of surface to be revetted.
3. If sandbags are used for fills, parapets, or breastworks, about 195 are required for each 100 cubic feet of fill.

(b) Ordinary sandbags should be used for temporary revetting only. Where bags are to be in place for a month or longer under average conditions of moisture, they must be rotproofed or filled with soil partly stabilized with cement or bitumen. The latter method usually is simpler in the field.

(c) Sandbags are laid as follows (fig. 9) :

1. Fill bags uniformly about three-fourths full.
2. Tuck in bottom corners of bag after filling.
3. Build walls with slope 3 on 1 to 4 on 1.
4. Place bags perpendicular to slope.

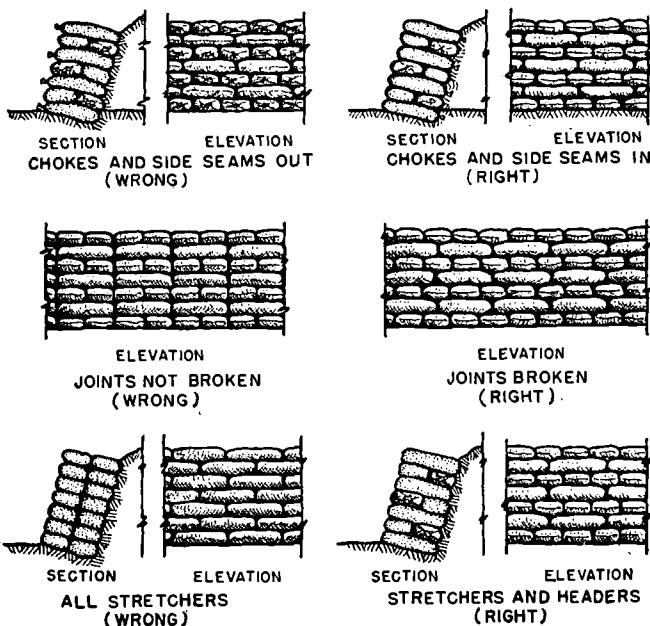


Figure 9. Sandbag revetment.

5. Place bottom row headers.
 6. Alternate intermediate rows as headers and stretchers.
 7. Complete with a top row of headers.
 8. Place side seams and choked ends on the inside.
 9. Break joints and beat bags into place and into rectangular shape with back of shovel, or tamp with feet.
- (d) In presence of the enemy, sandbags are used for speedy and silent preparation of defensive positions in frozen ground. Freezing sandbags by pouring water on them improves their protective properties for the duration of cold weather.
- (2) *Sod revetment.* Thick sod makes durable revetments. Sods are cut about 18 by 9 inches, laid grass down, except for top layer, and pinned together with wooden pegs. The procedure given for construction of the sandbag revetment applies to sod revetting. (See fig. 10.)
 - (3) *Ice-block revetment.* In the absence of other materials during winter operations, blocks of frozen snow or ice are cut and stacked to form a revetment. After the blocks have been stacked, water is poured over them to improve the strength of the revetment.
 - (4) *Log revetment.* In wooded areas, small timber may be used for revetting materials.
 - (5) *Expedient revetting.* Expedients such as empty ration crates, empty shell cases, or am-



Figure 10. Sod revetting on a trench wall.

munition boxes filled with dirt, sand, rocks, and packed snow can be used for revetting.

b. Surface or facing revetment. Surface or facing revetment serves mainly to protect the revetted surface from effects of weather and damage caused by occupation. It must be supported. When strongly constructed, it retains loose material. Its top should be about 8 inches below the ground level to prevent its being snapped or damaged if tanks cross the revetted wall. It may be constructed from issue or natural material.

(1) *Issue material.* Issue material, such as burlap and chicken wire, wire mesh, expanded metal (XPM), or corrugated iron, may be obtained in limited quantities at engineer dumps. These materials when installed are held in place by wooden pickets, at least 3 inches in diameter, or by issue shell pickets. Pickets are driven into the floor and held at the top by holdfasts. When installing this type of revetting (fig. 11), the following operations are necessary:

- (a) Cut grooves for pickets into wall to be revetted. Space grooves $1\frac{1}{2}$ to 6 feet apart, depending upon revetting material to be used.
- (b) Prepare holdfast in front of each groove. Holdfast anchor picket should be from 8 to 10 feet from wall.
- (c) Place two end pickets loosely. Stretch material between them and hold taut while end pickets are tightened.
- (d) Drive all pickets at least $1\frac{1}{2}$ feet into floor and fasten tops to anchor pickets with two turns of No. 10 wire. Draw pickets tight by



Figure 11. Installing burlap and chicken wire revetment.

racking. Pickets draw material tight against surface to be revetted.

- (2) *Natural material.* Since issue material often is difficult to obtain in the field, most revetting is done with natural material such as brush and cut timber obtained at the site (see figs. 12, 13, and 14).
 - (a) *A brushwood hurdle* (fig. 12) is a woven revetment unit usually 6 feet long and of required height. Brushwood less than 1 inch in diameter at butt is woven on a framework of sharpened pickets driven into the ground at 18-inch intervals. When finished, hurdle is removed and carried to erection site where pickets are driven into floor and held in place by holdfasts.
 - (b) *A continuous brush revetment* (fig. 13) is constructed by driving 3-inch-diameter pickets at 1-pace intervals in the trench

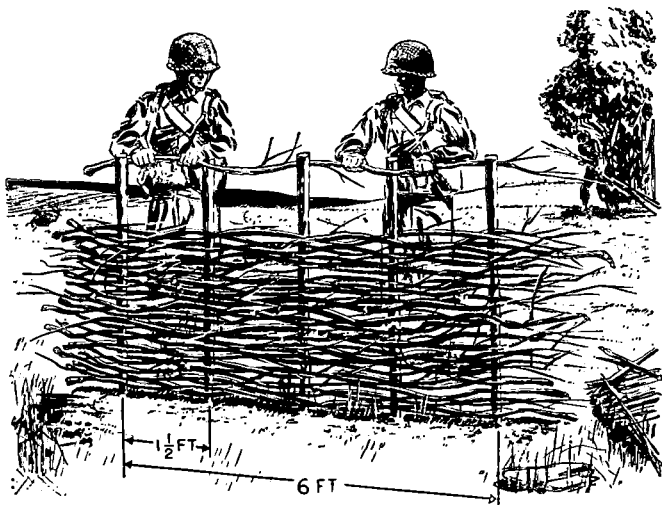


Figure 12. Building a brushwood hurdle.

floor and about 4 inches from the surface to be revetted. Space behind the pickets then is packed with small, straight brush laid horizontally. Pickets are drawn tight by holdfasts.

- (c) *A cut-timber revetment* (fig. 14) is the principal natural means of revetting fox holes and emplacements. It is similar to the continuous brush revetment, except that a horizontal layer of small timbers, cut to fit the length of wall to be revetted, is used in place of brush. Pickets are held in place by holdfasts or struts. When available, dimension lumber may be used in a similar manner.

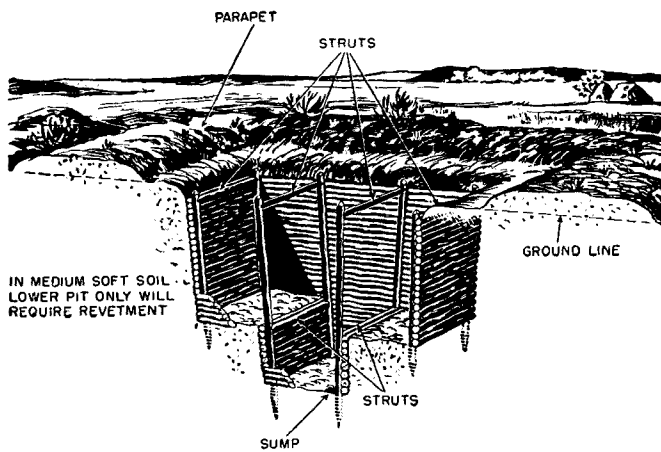


Figure 13. Continuous brush revetment in a trench.

17. BREASTWORKS AND PARAPETS. a. **Natural breastworks and parapets.** Natural breastworks and parapets should be utilized fully wherever they exist in the combat zone, not only because of the great saving in time and labor, but also because they are the best type natural cover and concealment. Stonewalls, hedgerows,



① Dimension lumber used as revetting



② Saplings used as revetting

Figure 14 Two types of cut-timber revetments.

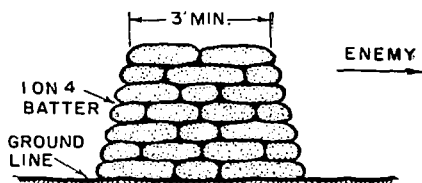
and low ridges often found in woodland ; dikes in marshy areas ; and railroad beds and roads across fills in marshy or undulating country make ideal breastworks. Hedgerows make excellent lines of defense. Firing ports and embrasures may be cut through the dirt ridge forming the base of the hedgerow, thus providing an effective, well-camouflaged strongpoint (fig. 15). Urban areas present a variety of ready-made parapets and breastworks in the form of stone, brick, and masonry walls and rubble from demolished buildings. Natural breastworks and parapets ordinarily must be improved and strengthened. Weapons emplacements and personnel shelters are dug, and weak points are reinforced with sandbags, dirt-filled ammunition boxes, or other forms of expedient strengthening.



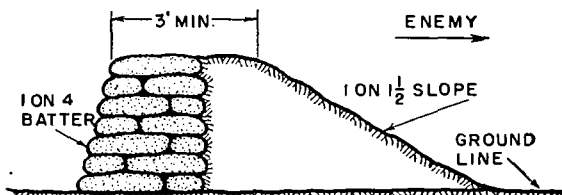
Figure 15. A machine-gun position cut through a hedgerow.

b. Deliberate breastworks and parapets.

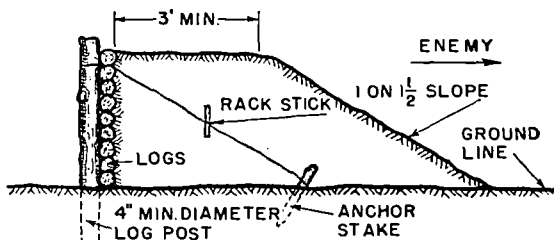
- (1) If no ready-made line of defense is available when on the defensive, and if time permits before an expected enemy attack, deliberate breastworks and parapets are built for protection when soil conditions or subsurface water prevent excavation. They also are used with dug-in emplacements to save extra digging, and are built at least 3 feet thick at the top to protect against caliber .30 bullets and shell fragments. Breastworks and parapets should be free of loose rocks and pieces of wood; if they contain this material, sandbags or other forms of nonshattering revetting should be used. Figure 16 illustrates various types of deliberate breastworks.
- (2) Breastworks of snow can be erected if time is short, or if equipment for excavation of frozen ground is not available. To afford limited protection against enemy small-arms fire, snow must be tamped solid and water poured over it to increase its protective qualities. It then is camouflaged by scattering loose snow over it. The rear side of the breastwork should be revetted with sandbags filled with sand or snow. Alternative materials for revetting are round timber, wire netting, or wooden planks secured to posts, as in a fence.
- (3) If it is impossible to drive in or anchor the posts, simple trestles of triangular cross section should be erected at intervals of 5 to 6½ feet, as shown in figure 16. It is best to make the trestles first and then carry them to the



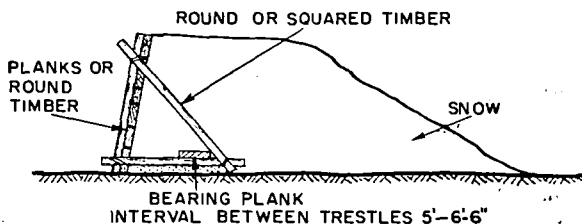
① SANDBAG BREASTWORK



② SANDBAG AND EARTH BREASTWORK



③ LOG FENCE AND EARTH BREASTWORK



④ LOG AND SNOW BREASTWORK

Figure 16. Various types of deliberate breastworks.

site. After adding the revetment and bearing planks, snow is shoveled or pushed over the trestle with a bulldozer blade and tamped hard. The center of the snow wall can be formed of any other suitable material such as round timber, stones, gravel, sand, and the like.

- (4) If it is impossible to dig more than a foot or two deep in desert terrain because of rock strata or excessively hard soil, bulldozers can be used to form a sand parapet, which must be revetted.

18. CAMOUFLAGE. a. General. Concealment is of prime importance in constructing defensive works. Before any excavation is started, all turf, sod, leaves, snow, or forest humus is removed carefully from both the area to be excavated and from that on which excavated soil is to be piled. This material is set aside and replaced over the spoil when the work is completed. (See fig. 17.) To prevent discovery of the work during excavation in open country having little or no natural cover, camouflage nets are suspended from stakes or trees before excavation is started. The workers confine their activities to the area beneath the camouflage net. The net is suspended high enough above the ground to permit excavation without snagging by equipment or intrenching tools. After the excavation has been completed and the spoil covered with sod or other natural camouflage material, the net is lowered close to the ground so it is inconspicuous from ground observation. Nets are kept in position when the weapon is not being fired. Arrangements are made to withdraw or lift the net during action.



Figure 17. Partial camouflage of trench parapets with sod. Note carefully piled chunks of sod to be placed on the completed parapet.

b. Winter.

- (1) In winter, snow completely changes the landscape, concealing details of terrain and military installations from ground and air observation. However, trails, paths, and tracks of vehicles and troops are easily recognized from the air. For this reason, all vehicular and troop activities should be confined wherever possible to wooded areas, areas having deep shadows cast by terrain features, existing roads, natural hollows and depressions in the terrain, or the edges of open, snow-covered areas. During thaws, the terrain presents to the air or ground observer a mottled pattern of dark and light

patches which adds greatly to the concealment of ground troops and their activities.

- (2) Snow must be cleared from an emplacement site and piled to one side to be available for camouflage when the emplacement is completed. Trenches may be covered with planks, brush, sheet-iron, or other expedient material on which snow should be heaped.

c. Desert. In desert and barren Arctic areas, the use of dummy installations, vehicles, gun positions, and the like is of more importance than in any other type of terrain because military operations in this flat, open, sparsely vegetated country are practically impossible to conceal. The enemy may be easily confused and deceived as to the exact strength and character of friendly troops and their intended operations by the clever, careful use of dummies. See FM 5-20G for detailed information on decoys.

d. Jungle. In the jungle, near-perfect concealment is afforded troops wearing mottled camouflage suits. Emplacements need very little artificial camouflage because the dense undergrowth and vegetation adequately camouflages them. Positions in open clearings in the jungle must be held to a minimum as these areas are always carefully viewed for military activity by enemy observers. For a more complete discussion of camouflage, see FM 5-20 and TM 5-267.

19. OVERHEAD COVER. a. General. Overhead cover provides additional protection from artillery time fire, tree bursts, and fragmentation from ground bursts, and permits the occupants of intrenchments to remain in firing position while under such fire. In hasty positions,

overhead cover gives splinter protection only and is not protection against direct hits of heavy artillery, bombs, or rockets.

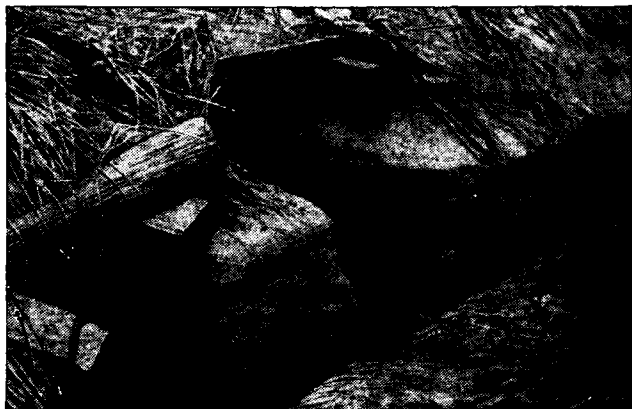
b. Expedient materials. In hasty positions, any durable type of material (a door from a building; a piece of galvanized iron; armor plating from a wrecked tank or vehicle; empty ammunition boxes or crates filled with sand, rocks, dirt) may serve as overhead cover; anything covered with dirt or spoil from the immediate area to help cushion or deflect fragments may be employed. If time, the situation, and materials permit, overhead cover is strengthened and improved as long as this does not limit effective delivery of fire from the position. Construction of overhead cover similar to that shown in figures 18 and 19 is of expedient nature and is used in individual shelters for combat troops. Over-



Figure 18. Hasty overhead cover of narrow-gage rails, sheet metal, and dirt for a machine-gun position.



① For a fox hole



② For trench shelters

Figure 19. Expedient timber and dirt overhead cover for an individual shelter.

head cover as shown in figures 20, 21, 30, and 34 is the type desirable if the situation permits, but requires considerable time to construct.

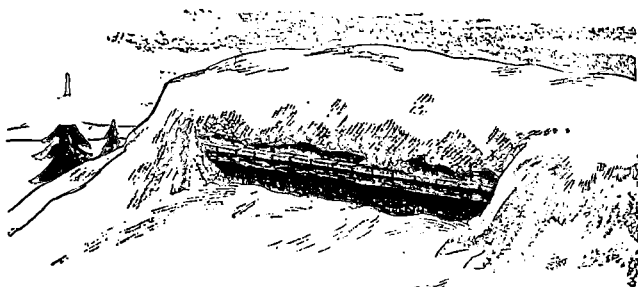
c. Recessing. When material to support an overhead cover is not available, the bottom of one side of the fox hole can be recessed to use the resultant overhang as cover if the soil is firm enough. (For cave-type shelters, see pars. 30 and 89.)

d. In urban areas. In urban or inhabited areas, buildings offer the best overhead cover available. An infantryman firing from a basement window in all but the smallest buildings has overhead protection against direct hits from all sizes of artillery shells, bombs, and rockets.

e. Icecrete. A good overhead protection in winter is *icecrete*. Icecrete is a dense, frozen mixture of sand and water, or sand with gravel, (or broken stone) and water, which is many times stronger than normal ice. It is especially suitable for the reinforcement of breastworks as well as for the construction of overhead covers and shelters (fig. 20). Icecrete can be protected against the effects of rising temperature for a considerable period by a covering of dirt.

(1) The composition of icecrete is as follows:

- (a) *Sand.* A high proportion of fine sand increases the strength. Sand alone makes the strongest mixture.
- (b) *Gravel.* If there is not enough sand available, gravel or broken stone can be used. The proportion of fine sand should, however, not fall below 10 percent.



OBSERVATION EMBRASURE
(camouflage omitted)

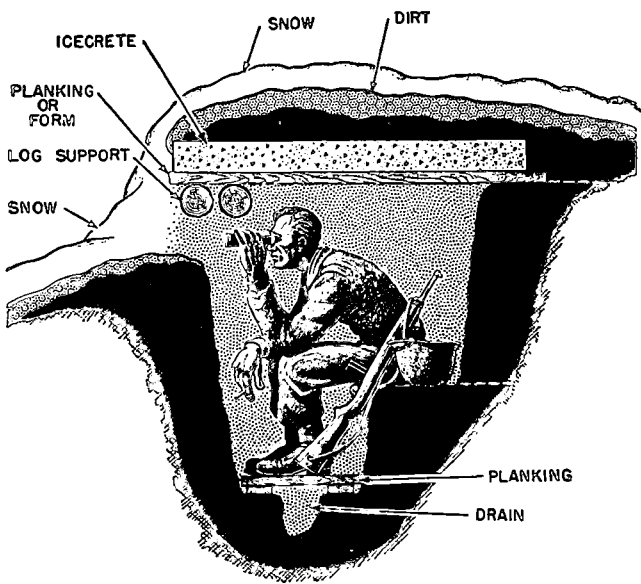
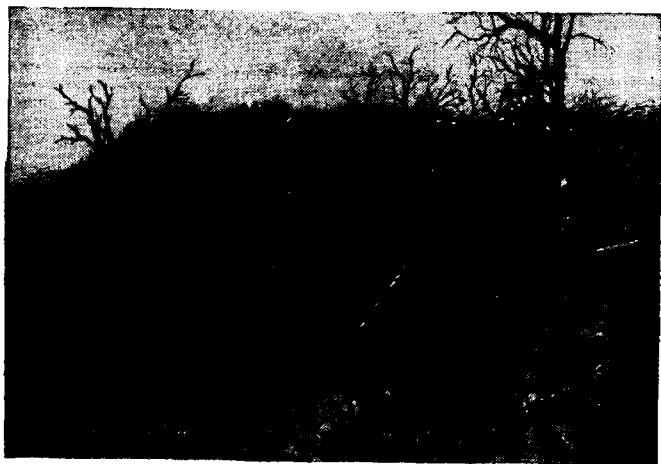


Figure 20. Icecrete overhead cover on an observation port.

- (c) *Soil*. A small proportion of topsoil, clay, or mud is acceptable.
- (d) *Water*. Enough water should be added to make the mixture slightly liquid.
- (2) The mixture can be prepared in a concrete mixer or in a trough, adding the water gradually. The wet mixture is immediately placed in the forms in layers of from 4 to 6 inches. Each layer is tamped to consolidate the mixture. If gravel is used, the material is pre-mixed without adding water and placed in the forms in layers 4 to 6 inches thick; water is then poured in to complete saturation. This is accompanied by stirring and tamping. Successive layers should be added as soon as the previous layer has begun to freeze. To hasten the process of freezing, sand and gravel should be at a freezing temperature before water is added; the water should be as cold as possible.
- (3) Material frozen in large lumps must be broken up before mixing. Ordinary wooden forms should be used, but snow, ice, earth, straw, or brushwood can be substituted. To protect underground shelters against warming from inside (heat from stoves) the inner forms are left standing; outer forms are removed as soon as possible to hasten freezing. A sheet of 4-inch-thick icecrete will freeze in 4 to 6 hours at 13° F.

f. Deliberate overhead cover. Other examples of overhead cover for emplacements are shown in fig. 21.



① Log and dirt



② Log, stone, and sandbag

Figure 21. Example of overhead cover.



③ Cover formed by burrowing under a rock

Figure 21. Example of overhead cover—Continued.

CHAPTER 2

INTRENCHMENTS AND EMPLACEMENTS

Section I. EMPLOYMENT AND REQUIREMENTS

20. EMPLOYMENT. a. When employed.

- (1) Field fortifications are *defensive* measures only. In World War II the infantry learned that to stop and dig in when not actually forced to do so by the enemy was a costly mistake. Troops permitting themselves to be immobilized in such a manner are likely to be subjected to deadly mortar and artillery concentrations which cause excessive casualties.
- (2) On the defensive, in static situations, or in consolidating ground taken from the enemy, field fortifications increase the combat efficiency of troops by affording protection to weapons and personnel against weather and enemy action. They must be used skillfully to further the mission of a unit and *should not be allowed to lead to a passive* attitude on the part of the defending troops. Troops on the defense must provide themselves with adequate fields of fire covering probable routes of enemy approach. Field fortifications provide these troops with a maximum amount of cover and concealment.

b. Employment in forward areas. In forward areas, all

troops dig intrenchments for themselves and emplacements for their weapons. This applies to crews of all weapons; personnel guarding road blocks, bridges, or tactical headquarters; and troops in bivouac or assembly areas.

c. Use of existing emplacements. Attacking troops make temporary use of former enemy positions, shell and bomb craters, cellars or basements of buildings, ditches, hedgcs, trees, stone walls, and other forms of existing firing positions offering cover and concealment (fig. 22). It is not always good practice to make use of former enemy positions as enemy mortars and artillery are often registered on their old positions, particularly the larger ones.

d. After an offensive.

- (1) It may be necessary at times, particularly after an offensive, to take up positions on forward slopes of hills or on open ground (fig. 23) devoid of natural cover and concealment. Since the enemy usually has excellent observation of such positions, emplacements should be excavated which are stronger constructed and better concealed than normal emplacements. During daylight they should be manned only by skeleton crews manning crew-served weapons and observation posts. This light defense greatly decreases the number of troops exposed to enemy artillery, mortar, and rocket fire. The rest of the troops prepare positions out of range of hostile observation, such as on the reverse slopes of hills.



① Behind trees, fallen logs, and stumps



② Behind piles of equipment

Figure 22. Advancing troops taking advantage of natural cover to protect themselves from enemy fire.



① Riflemen dug in in dry ground



② A bazooka team and riflemen hastily dug in in muddy ground

Figure 23. Infantry occupying hastily dug position in an open field after offensive action.

- (2) At night or when hostile observation is limited by the weather, the forward positions are fully manned and individual emplacements are improved and strengthened. Should enemy activity increase, indicating a possible attack, all positions are fully manned.

e. In winter.

- (1) If the depth of snow is great in winter, field works must be constructed partly in snow and partly in the ground. Small shafts are sunk to the full depth and then are connected by trenches dug in the snow. The deepening of these trenches into the ground can be carried out later. If there has been only a short frost before the snowfall, the ground will be only slightly frozen, since the snow sets as a protective layer against hard freezing.
- (2) Troops on the defensive in winter have a tendency to remain in the vicinity of inhabited localities and roads. They use existing structures or ruins as covered defensive positions and as shelters from enemy fire and inclement weather. For this reason, much of the fighting in winter centers around these areas, thus making the fortification of these localities and the strengthening of positions seized from the enemy of particular importance.

f. In urban areas. In inhabited localities, the basic defensive positions for riflemen, machine guns, antitank weapons, and mortars are located in buildings, usually in basements with windows at ground level, or on the first floor. These positions are further strengthened by sandbag, brick, or rubble revetting inside the walls of

the building. Mortars have to be located behind a building or in a roofless building.

g. Against mechanized attack. In addition to their two primary missions (field of fire and cover and concealment), intrenchments and emplacements are built to provide protection against mechanized attack as far as practicable. Rocks or other pieces of hard material should not be left on or near the edges of a dug-in position because, under the weight of a tank, such objects cave in the walls of the position.

21. REQUIREMENTS. Intrenchments and emplacements must meet the following requirements:

- a.** Permit each individual or weapon crew to accomplish the assigned fire mission.
- b.** Be simple and easily constructed.
- c.** Provide maximum protection with minimum time and labor.
- d.** Provide all-around defense.
- e.** Afford maximum concealment.
- f.** Provide protection against mechanized attack.

Section II. HASTY INFANTRY INTRENCHMENTS AND EMBLEMENTS

22. GENERAL. Hasty infantry intrenchments and emplacements normally are dug by troops in contact with the enemy and when time and materials are limited. Hasty positions always should be supplemented with overhead cover and strengthened as conditions permit. Table II gives estimates of the man-hours required to excavate various types of infantry weapon emplacements. Figure 24 shows a typical hasty firing position for a rifleman.

TABLE II. *Excavation and Camouflage Data for Infantry
Weapon Emplacements in Average Ground*

	Type	Area to be camouflaged (feet)	Excavation (cubic feet)	Man hours required
EMPLACEMENTS				
Rifle	Fox hole.....	5 x 8	32	1.25
Automatic rifle	Fox hole.....	10 x 10	37	1.50
Rocket launcher.....	Pit	5 x 5	50	2
	Pit fox hole:			
	w/o fox hole shelter.....	10 x 10	25	1
	with fox hole shelter.....	10 x 10	87	3.5-4
Machine gun, light, cal. .30.....	Horseshoe	15 x 15	123	5
	2 fox hole.....	12 x 12	64	2.50
Machine gun, heavy, cal. .30.....	Horseshoe	15 x 18	143	5.75
	3 fox hole.....	15 x 15	96	3.75
60-mm mortar.....	Pit	14 x 14	70	3
81-mm mortar.....	Pit	16 x 16	108	4.33

57-mm recoilless rifle	Pit (for 57-mm rifle only)	5 x 5	50	2
and	2 fox hole.....	16 x 16	84	3.50
75-mm recoilless rifle	Horseshoe	16 x 16	188	7.50
	Trapezoidal	12 x 8	150	6.00

SHELTERS

1-man	Prone shelter	5 x 8	27	1
	One-man fox hole:			
	w/o sleeping shelter.....	5 x 8	32	1.25
	with sleeping shelter.....	5 x 10	68	2.75
2-man	Two-man fox hole:			
	w/o sleeping shelter.....	10 x 10	56	2.25
	with sleeping shelter.....	10 x 10	92	3.75
3-man	Three-fox hole emplacement			
	V-shape	10 x 15	240	9.75
	Three-fox hole emplacement			
	Y-shape	15 x 16	298	11.50

INTRENCHMENTS

Connecting trench.....	Shallow (10-yd. section).....	6 x 30	150	6
Standard trench.....	10-yd section with one firing position	8 x 30	515	21
Special trench.....	Artillery or rear area installation (2-yd section).....	8 x 6	48	2



Figure 24. Rifleman's hasty firing position cut through a hedgerow.

23. IMPROVED CRATER. a. The ground between opposing armies usually is pock-marked with craters of varying sizes caused by exploding shells, bombs, mines, and rockets. For troops advancing over this ground, these holes offer the most readily available form of cover and concealment as well as partly defiladed firing positions. Should the situation become temporarily stabilized, the holes may be deepened easily and otherwise improved with the infantry intrenching tool.

b. Craters with diameters of about 2 to 3 feet lead to the best improved positions. The ground is shattered

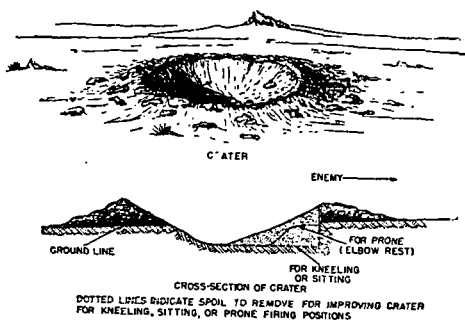


Figure 25. Improved crater.

enough to make digging easy but is not broken up in so large an area that the soldier might be crushed under a tank attack because of weakened emplacement walls.

c. To improve a crater, dig down vertically on the enemy side of the crater lip and fashion a comfortable prone, kneeling, or standing firing position. (See fig. 25.) Any of the infantry emplacements described in the following paragraphs may be developed from a small crater.

24. SKIRMISHER'S TRENCH. a. This shallow pit-type emplacement (fig. 26) is designed to provide a temporary, hasty, prone firing position for the individual rifleman. When the situation demands instant shelter from heavy enemy fire and when existing defiladed firing positions are not available, each soldier lies prone or on his side and, with his intrenching tool, scrapes and piles the soil in a low parapet between him and the enemy. Thus, a shallow, body-length pit can be formed quickly in all but the hardest ground. The trench should not be dug perpendicular to the enemy

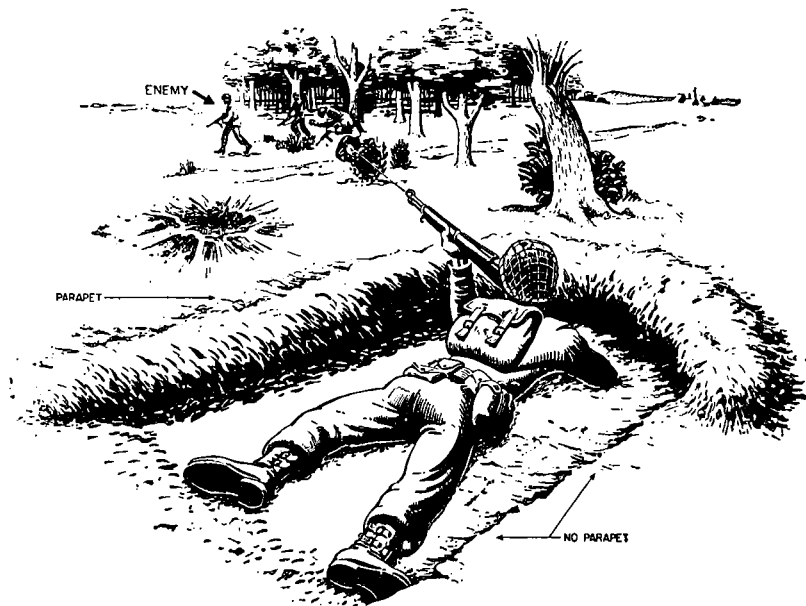


Figure 26. Skirmisher's trench.

line of fire because this presents a target inviting enfilade fire.

b. In a skirmisher's trench, a soldier presents a low silhouette to the enemy and is afforded some protection from small-arms fire. Should the general attack halt along this line of advance, the trench can be developed into a fox hole. However, stopping an attack in flat, open country and digging in is resorted to only in the most extreme emergencies, or if the terrain makes it impossible to do otherwise.

25. FOX HOLES. Fox holes are the individual rifleman's basic defensive position. They afford a maximum of protection against enemy fire of all types (except direct hits) and the crushing action of tanks. Fox holes can be developed from well-sited craters, skirmisher's trenches, and snow holes. When time and materials permit, fox holes always must be improved by adding expedient types of overhead cover.

a. The size, shape, and method of constructing a fox hole as a *fighting hole* varies to fit existing tactical and terrain conditions. Whatever type hole is dug, provisions must be made to drain off rain or surface water by means of a sump. It also is necessary to construct a grenade sump to dispose of hand grenades tossed into the hole by the enemy. Except in tank-proof terrain, the fox hole must be deep enough to provide at least 2 feet of clearance between a soldier crouched in the hole and the rim of the hole to protect against the crushing action of tanks.

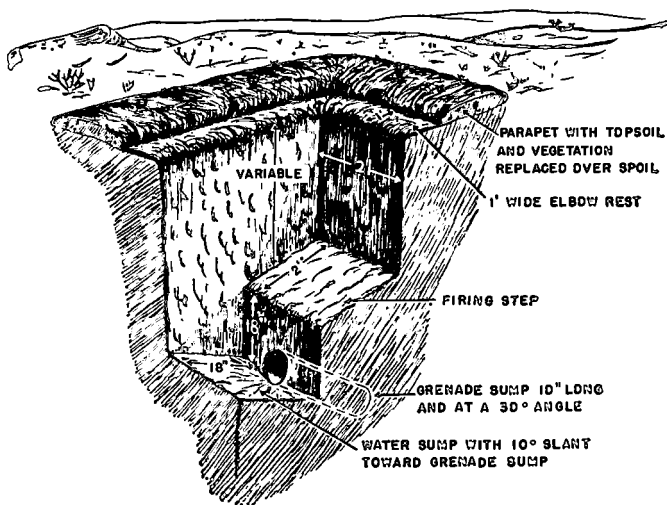
b. Fox holes usually are dug with the long side parallel to the front, but are distributed around weapons emplacements to provide all-around defense. All

fighting holes are sited primarily for a good field of fire; concealment is a secondary consideration.

c. In stable defensive positions, the fox hole may be enlarged to include a sleeping hole. The sleeping hole must have strong overhead cover.

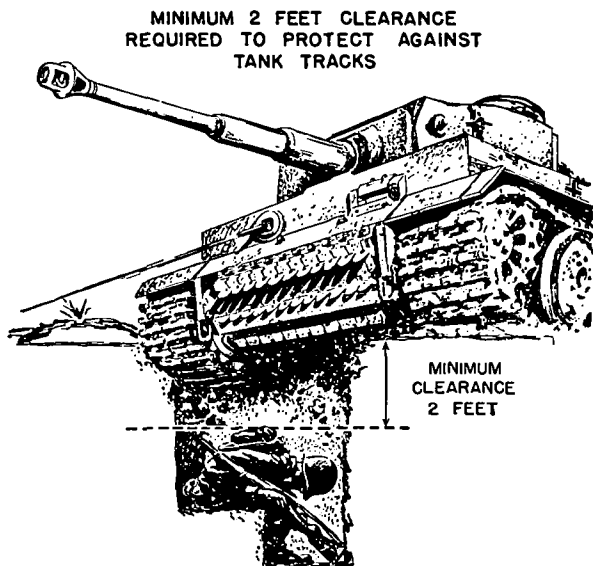
26. ONE-MAN FOX HOLE. a. **Dimensions.** The dimensions of the one-man fox hole (fig. 27) are as follows:

- (1) As small as practicable, to present the minimum target to enemy fire.
- (2) Wide enough for the shoulders of a man sitting on the firing step. Minimum width, 2 feet.
- (3) Long enough to permit using large-size entrenching tools. Minimum length, $3\frac{1}{2}$ feet.



① Dimensions

Figure 27. One-man fox hole.



② Protection from tanks

Figure 27. One-man fox hole—Continued.

- (4) At least 4 feet deep to the firing step, from which a standing man should be able to fire.

b. Sumps. A *water sump* is dug in one end to collect water and to provide a place for the feet of a seated man. It should pitch 10 degrees toward a grenade sump. The *grenade sump* should be at least 18 inches long, should pitch downward at least 30 degrees, and should not be over 8 inches wide (fig. 28).

c. Overhead protection.

- (1) *Against tanks.* In most types of soil, the fox hole gives positive protection against the

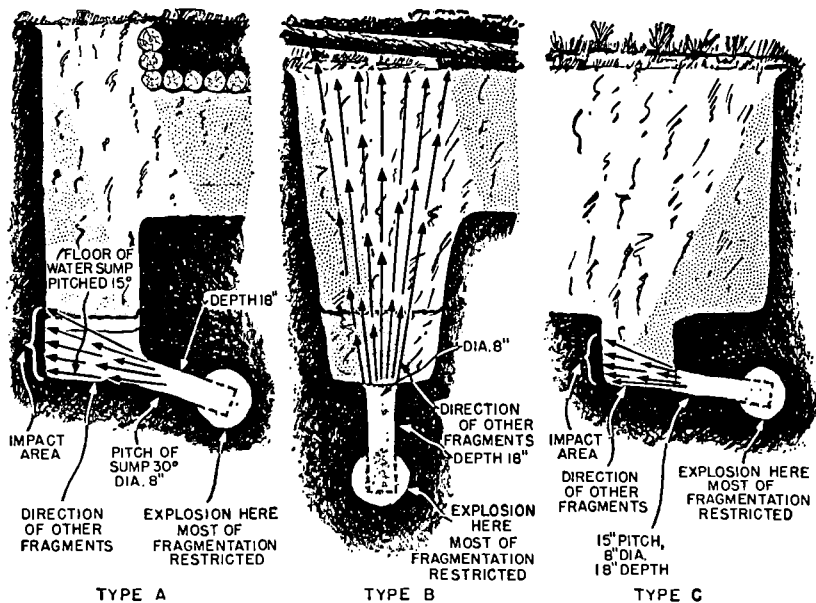


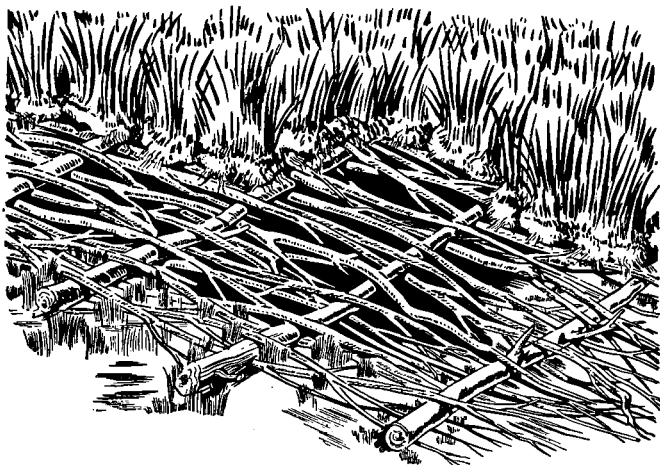
Figure 28. Three sump-type grenade catchers.

crushing action of tanks if the soldier crouches at least 2 feet below the ground surface (see fig. 27②). In very sandy or very soft soils, it may be necessary to revet the sides to prevent their caving in.

- (2) *Against aerial bursts.* To protect individual riflemen in fox holes against accurate aerial bursts, fox holes must have overhead cover. Expedient methods are described in paragraph 19. In some cases, 4- to 6-inch timber can be cut to fit and covered with earth fill. In other situations, any expedient material at hand can be made to serve when covered with 6 to 8 inches of earth, snow, or sand.

d. Fox hole camouflage. If practicable, the spoil from digging is removed to an inconspicuous place and a camouflage cover improvised. This consists of a frame garnished with grass or natural foliage to match the surroundings, or covered with a shelter half or other expedient material and further covered with snow or some other material according to local terrain conditions (fig. 29). This technique is especially effective against a mechanized attack supported by foot soldiers. Riflemen remain concealed until the tanks have overrun the position, then they rise up and attack the enemy foot soldiers following the tanks. This hole, or variations of it, is sometimes called a "spiderhole."

e. Parapet. Some spoil is piled around the hole as a parapet, leaving a berm or shelf wide enough for the soldier to rest his elbows on while firing. The parapet should be about 3 feet thick and one-half foot high. If turf or topsoil is used to camouflage the parapet, the topsoil is removed from an area 10 feet square and set



① Details of cover construction



② Camouflaged fox hole in use

Figure 29. Fox hole camouflage.

aside until the fox hole is complete. In winter, packed snow makes a good parapet.

27. TWO-MAN FOX HOLES. a. In defensive positions, the two-man fox hole (fig. 30) generally is preferred to the one-man hole for the following reasons:

- (1) It is more easily prepared. One man can provide protection while the other is working on the hole.
- (2) It affords relief and rest for the occupants. One man rests while the other is on the alert.

MATERIALS SHOWN
ARE EXPEDIENT

DIMENSIONS GIVEN
AS GUIDE ONLY

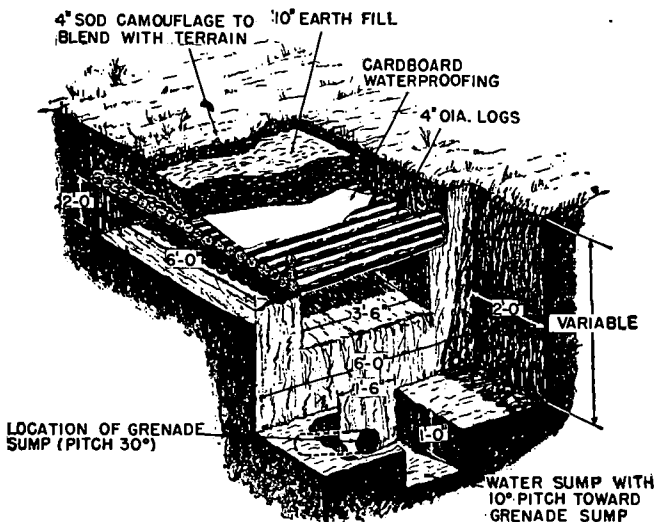


Figure 30. Two-man fox hole.

Thus, positions are manned effectively for longer periods of time.

- (3) If one soldier becomes a casualty, the position still is occupied and does not cause a gap in the line.
- (4) Under pressure, the psychological effect of this comradeship keeps the men in position longer than one man is inclined to remain alone.
- (5) It affords greater comfort, especially in cold weather when the two occupants can double up on blankets and shelter halves.

b. Two-man fox holes often are used as observation posts. Overhead cover is provided whenever possible.

28. V-SHAPED THREE-MAN FOX HOLE. a. General.

The V-shaped three-man fox hole provides all-around defense and is especially effective in jungle-type terrain. It can be developed from three one-man fox holes by connecting them with trenches (fig. 31). The three-man fox hole provides a more active defense, easier communication, and more supply and sleeping space. Troops can defend against an attack from any direction. The principal disadvantages to this type position are the time required for construction and the difficulty of camouflage, except in jungle terrain.

b. Development.

- (1) The V-shaped three-man fox hole is developed from three one-man fox holes by placing them so the three positions form a V-pattern. The distance from one fox hole to either of the other two must be at least $9\frac{1}{2}$ feet. Connecting

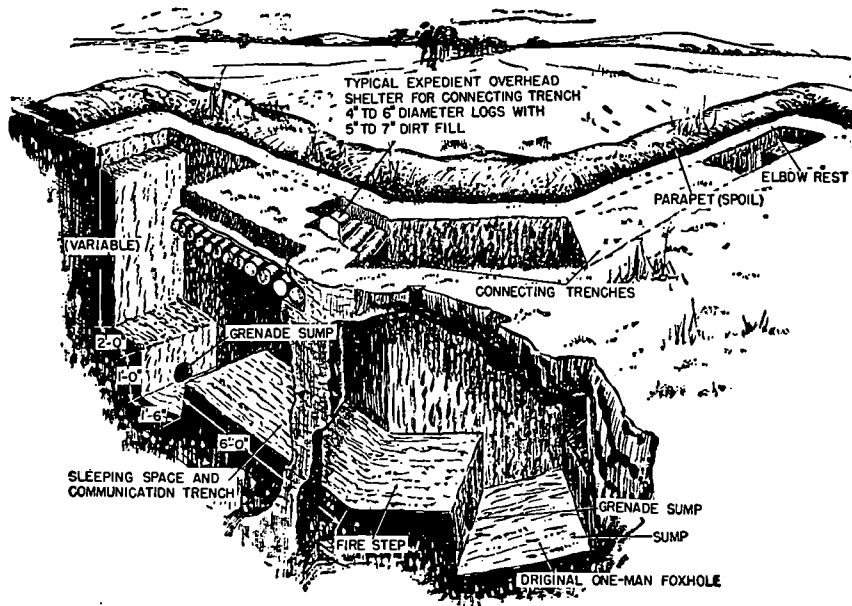


Figure 31. V-shaped three-man fox hole.

trenches between fox holes and grenade sumps in each fox hole then are dug.

- (2) For overhead protection, cover trenches with material at hand, using any expedient such as timber or scrap metal; then cover with earth fill. In camouflaging the position it is important to disrupt the characteristic V-pattern.

29. Y-SHAPED THREE-MAN FOX HOLE. a. General.

- (1) The Y-shaped three-man fox hole can be developed from a one-man fox hole and is adaptable for all-around perimeter defense in jungle-type terrain. It provides a means of desirable comradeship for troops maintaining a defense. The trenches dug between the fox holes provide easy communication and allow space for supplies and for resting or sleeping.
- (2) The principal disadvantages are reduced fire power in any one direction, because of the masking of fire of one or more of the defenders, and the relatively extended time of construction. Camouflage is difficult because of the geometrical pattern of the positions.

b. Development.

- (1) The Y-shaped three-man fox hole consists of three one-man fox holes placed so the three positions form an equilateral triangle. The distance between fox holes should be $16\frac{1}{2}$ feet. The center of the resulting triangle then is located and marked. Each fox hole should be at least 6 feet from this center. Lay-out is illustrated in figure 32,

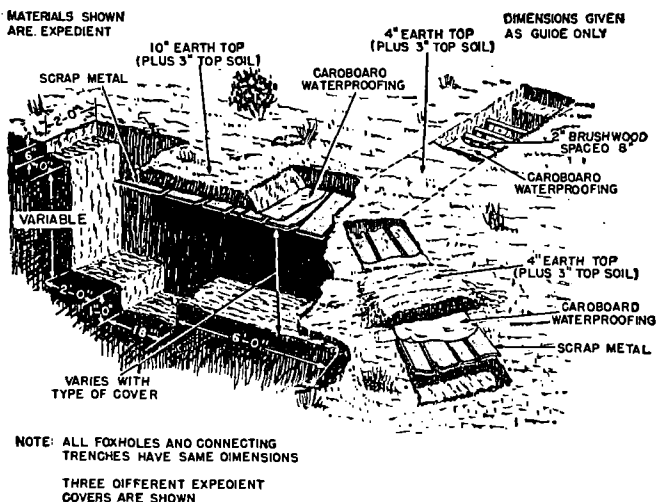


Figure 32. Y-shaped three-man fox hole, showing different expedient covers.

- (2) Communication trenches from each fox hole to center of triangle and a grenade sump in each fox hole then are dug. The trenches are covered with any expedient material, such as timber or scrap metal, and then covered with earth fill. Timber cover is illustrated in figure 30. In camouflaging the position, the characteristic Y-pattern should be disrupted.

30. CAVE HOLES. a. Cave-type positions are very effective in jungle and mountainous terrain and in rugged hill country. They afford a maximum of cover and concealment, are the easiest of all individual positions to camouflage, and, because of their elevated position over surrounding low ground, make good observation posts

and provide excellent fields of fire. These positions are dug laterally into the slopes of hills, ridges, snow drifts, and snow banks. The size and shape of the interior varies with the individual constructing the position and the character of the soil. (See fig. 33.)

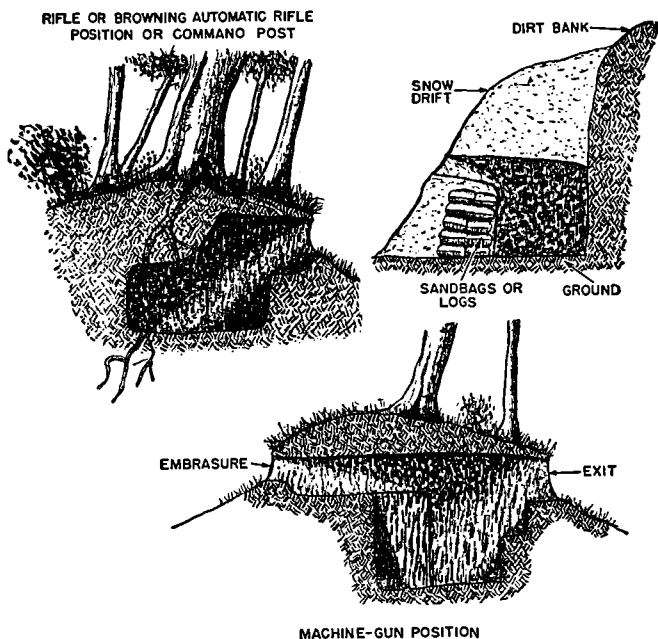


Figure 33. Three types of cave holes.

b. Caves in snow drifts should be revetted on the enemy side with sandbags, ice blocks, logs, or other material to stop bullets and fragments.

31. **OBSERVATION POSTS.** a. The battalion may establish one or more observation posts. These are located

on terrain features offering as extensive a view as possible of enemy-held areas (fig. 34). On the offensive, the observer seldom has time to dig an emplacement. Full use should be made of existing observation points such as tall trees in wooded areas, high points on a terrain feature (rocky outcroppings, mounds, rises in the ground, and the like), tall buildings (if in city areas), and other high natural and man-made structures. The ideal observation post has at least one covered route of approach and cover as well as concealment, while offering an unobstructed view of enemy-held territory. However, it is not wise to use the *highest* tree or building, or the most obvious high point because these points usually have been registered by enemy artillery. For this reason, church steeples, water towers, and tall, single trees should be avoided. When using high points as observation posts, the observer should select a position which will not silhouette him against the sky. Some visibility is sacrificed for cover and concealment.

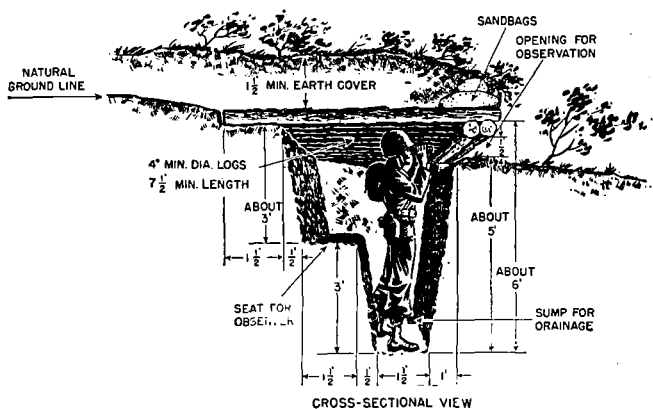


Figure 34. Observation post.

b. When opportunity permits, always dig in. The cave hole and the two-man fox hole with camouflaged cover are suitable for use as observation posts in defensive or static positions.

32. COMMAND POSTS. a. The chief factor to consider when setting up a command post is that it should be located equidistant from each of the units under its command to facilitate communication and control. Cover and concealment are the next most important factors to consider. In cities or towns, full use is made of the basements of buildings or other covered, concealed, and protected places. Former enemy fortifications are used whenever possible. (See fig. 35.)



Figure 35. A dug-in command post in a woods.

b. A command post is the nerve center of a unit in the field. To help keep the enemy from determining its location, vehicle and personnel activity in the vicinity

are held to a minimum, and blackout rules are strictly enforced at night. When the situation demands constant moving, mobile command posts; in the form of trailers or redesigned truck bodies, save much time and labor.

c. When on the defensive, command posts of small units and sections of larger units are dug-in. If necessary, a dug-in command post may be improvised easily from a truck's body bows and canvas top as shown in figure 36. This type affords protection from the weather and some shelter from blast, splinters, and small-arms fire. It consists of a rectangular pit about waist deep, the spoil forming a parapet about 1½ feet back from the edge of the pit. Similar shelter is given by a tent placed in a pit surrounded by a parapet. Some of the shelters described in chapter 3 give excellent protection and make good command posts.



Figure 36. Improvised command post.

Section III. INFANTRY WEAPONS EMPLACEMENTS (HASTY AND DELIBERATE)

33. GENERAL. On the offensive, infantry weapons are sited wherever natural or existing positions are available and with a minimum of labor and digging. The emphasis is placed on fields of fire and camouflage.

a. The positions described in this section are designed for defensive use in all types of terrain permitting excavation. These emplacements are prepared for machine guns, antitank weapons, mortars, and other infantry weapons, as well as their crews, when carefully sheltered and concealed positions covering routes of possible enemy approach are required. Where practicable, dummy emplacements are constructed for deception.

b. The automatic rifle is fired from a modified one- or two-man fox hole, as described in section II, this chapter. (See table II for an estimate of the man-hours required to dig these emplacements.)

c. Supplementary and alternate positions normally are dug for all infantry weapons in addition to the primary position. The primary position is well sited, dug in, and concealed and should be continually improved to obtain maximum cover and concealment. If dug, alternate machine-gun positions, equally well prepared, must be sited at least 100 yards from the primary position because enemy fire most likely to harass machine-gun positions is from mortars and artillery. In moving less than 100 yards, machine guns still are subjected to the same harassing fire. Whenever the situation demands, other automatic and semiautomatic weapons are shifted more easily and with less exposure to the enemy than machine guns.

d. In Arctic regions and under conditions of extreme cold, the firing of all weapons produces an ice fog in front of the weapon which discloses the position. This is particularly true of automatic weapons when there is no wind. The fog lingers and becomes denser the longer the weapon is fired, obliterating the target from the gunner's view and effectively disclosing the position to the enemy. With a little wind, the fog is blown away as it forms, leaving the gunner's view unmasked but still exposing his position. For this reason the selection of several alternate sites for each weapon is of great importance in Arctic climates. After it is fired a short time, the weapon should be moved to an alternate position to limit the chances of the weapon's being knocked out by the enemy after he has spotted the ice fog caused by the weapon's first firing. In Arctic snow-covered terrain, whenever possible, weapons should be located so they rest on the frozen tundra or ice rather than float on soft snow. If the snow is too deep to permit this, particularly with small arms, some type of firing base or platform must be improvised.

34. BROWNING AUTOMATIC RIFLE. a. **General.** The defensive emplacement for the Browning automatic rifle is developed from any one-man or two-man fighting hole by adding a circular or semicircular firing table and a bipod trench. (See fig. 37.)

b. **Constructing emplacement for Browning automatic rifle.**

- (1) Take position in the emplacement and point the rifle at the extreme right flank of the target.
- (2) Keeping the right elbow on the same spot, move the gun to the extreme left flank firing

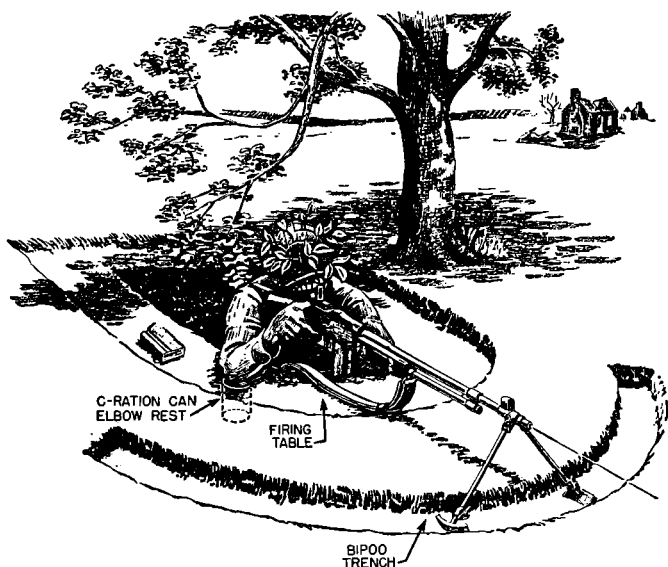


Figure 37. Defensive emplacement for a Browning automatic rifle.

position while the assistant gunner marks the track of the bipod.

- (3) Dig out the bipod trench. The firing table of the emplacement may be dug without exposing the digger.
- (4) A method for insuring that the gunner always takes the same position is to dig a hole at the right elbow position large enough to accommodate a C-ration can with the top of the can level with the ground. Then place an empty can in the hole with its open end up; tamp in dirt around the can, and fill can with dirt. This makes an easily found and comfortable elbow rest.

- (5) The elbow-in-can method, plus an aiming stake in front of the gun position, is a quick and simple method of night firing.
- (6) A home-made stock rest can be made for night firing by sinking an empty can in the ground and inserting in the can a piece of tree that fits tightly. Notch the piece of tree at the top so the lower swivel of the rifle butt fits snugly. Stake bipod legs or use aiming stakes.
 - (a) This emplacement gives better firing cover to the gunner and better concealment during daylight defense.
 - (b) When the gunner's elbow is in the can, the bipod trench acts as an automatic stop, enabling him to fire across the front of adjoining riflemen without endangering them. The weapon may be steadied by pulling the bipod against the trench.

35. CALIBER .30 MACHINE GUN (LIGHT). There are two types of emplacements for this gun—the horseshoe type and the two-fox hole type. As a firing position, the two-fox hole type is less flexible than the horseshoe type but, because it is easier to construct and more nearly tankproof, it generally is preferred.

a. Horseshoe type.

- (1) The gun is placed in firing position ready for action. The crew first excavates an open shallow pit about 7 feet long, 6 feet wide, and $\frac{1}{2}$ foot deep, the long side parallel to the enemy. The spoil is piled around in a parapet.
- (2) The emplacement is completed by digging out a horseshoe-shaped trench, about 2 feet

wide, along the rear and sides of the pit, leaving a chest-high shelf to the center and front

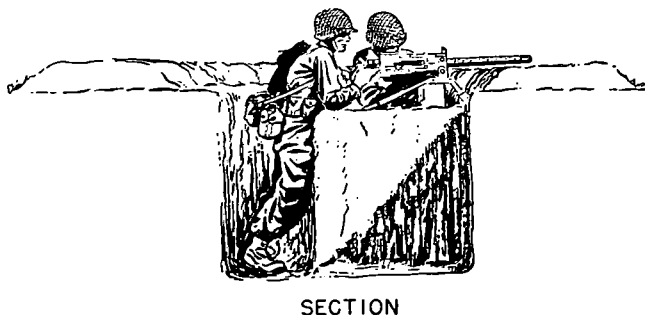
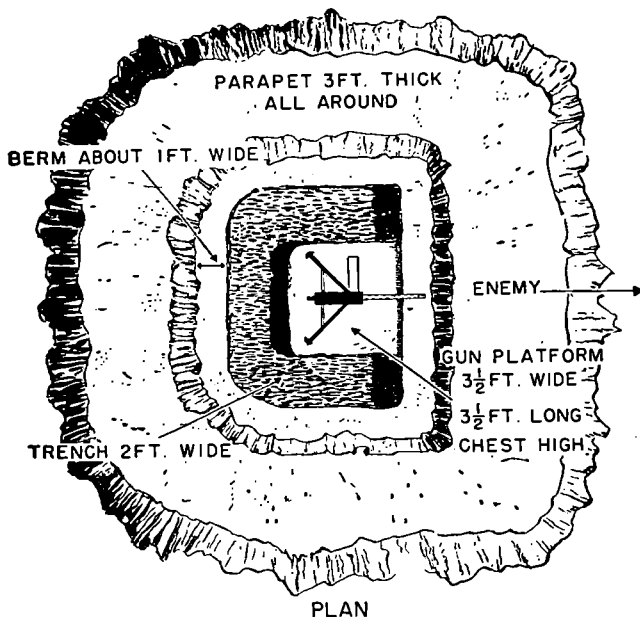


Figure 38. Horseshoe-type emplacement for caliber .30 light machine gun.

to serve as a gun platform (fig. 38). The spoil is piled around the emplacement to form a parapet at least 3 feet thick and low enough to permit all-around fire.

- (3) This emplacement furnishes protection against small-arms fire and shell or bomb fragments. In firm soil, this emplacement offers protection against the crushing action of tanks. In loose soil, logs about 8 inches in diameter, placed across front, rear, and sides of the emplacement and embedded flush with the top of the ground, help to make the emplacement resistant to the crushing action of tanks. When tanks appear about to overrun the position, the gunners pull the weapon to the bottom of the trench at the rear of the emplacement and then crouch down to either side.

b. Two-fox hole type. This emplacement (fig. 39) consists of two one-man fox holes close to the gun position. To lay it out, a short mark is scratched on the ground in the principal direction of fire. On the right of this mark, a fox hole is dug for the gunner. On the left of the mark and 2 feet to the front, another fox hole is dug for the assistant gunner. The spoil is piled all around the position to form a parapet, care being taken to pile it to permit all-around fire of the weapon. In firm soil, the two-fox hole type provides protection for the crew and the weapon against the crushing action of tanks. When tanks appear about to overrun the position, the gun is removed from the tripod and taken into one fox hole and the tripod into the other. The gunner and assistant gunner crouch in the holes.

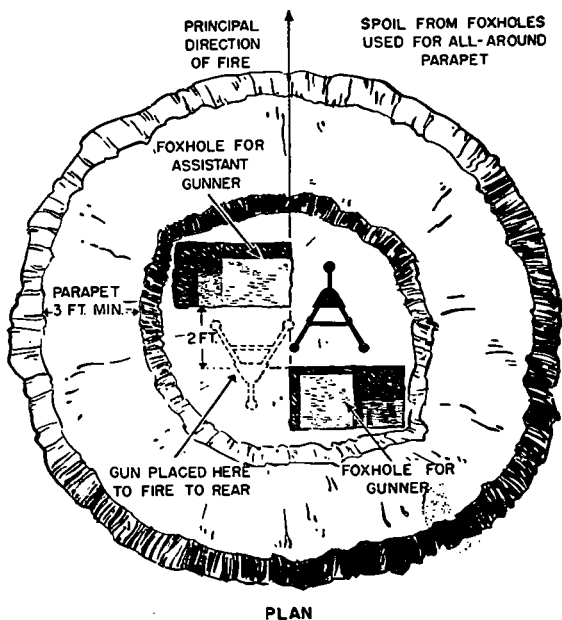
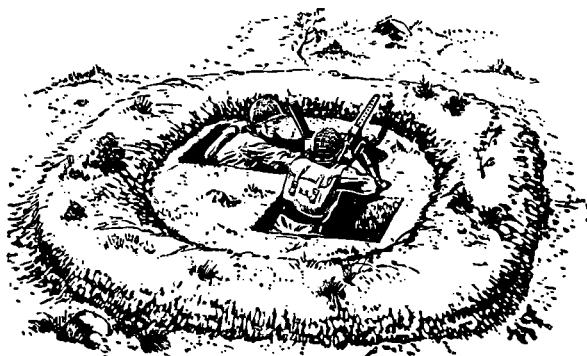


Figure 39. Two-fox hole type emplacement for caliber .30 light machine gun.

36. CALIBER .30 MACHINE GUN (HEAVY). Two types of combat emplacements for this gun are the *horseshoe type* and the *three-fox hole type*. In addition, there is

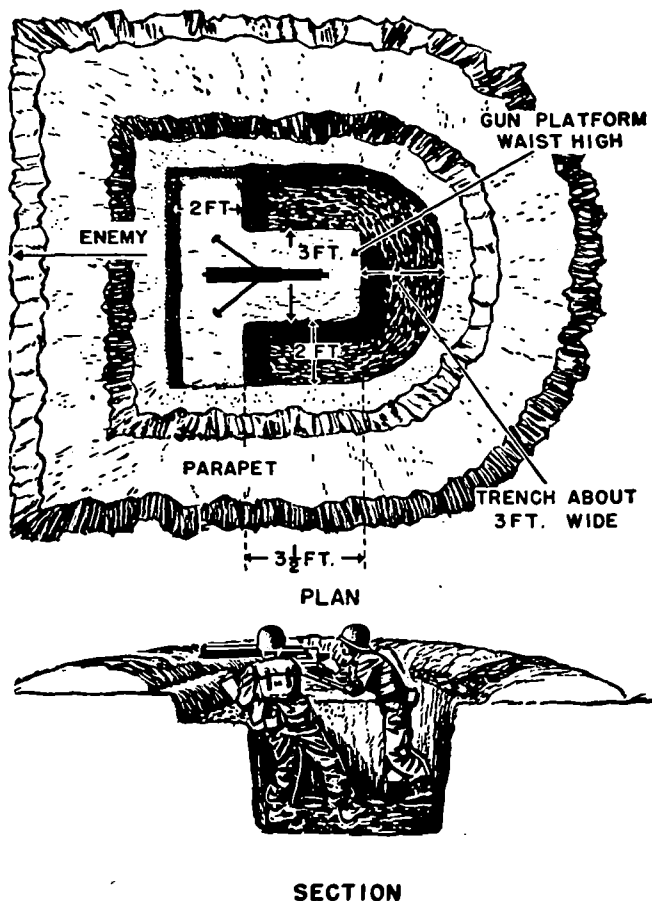


Figure 40. Horseshoe-type emplacement for caliber .30 heavy machine gun.

an antiaircraft type for use when the gun is mounted on an elevator for fire against air targets.

a. Horseshoe type. This emplacement (fig. 40) is similar to the one described for the light machine gun. The open shallow pit for the heavy gun is dug somewhat deeper, from 1 to 1½ feet below ground level. Construction procedure is the same. This emplacement permits easy traverse of the gun through an arc of 180 degrees. To fire aimed shots to the rear, the gunner must get out of the trench and sit on the forward part of the gun platform. In most types of soil, tanks can run over this emplacement without destroying it, the weapon, or the occupants. In loose soil, logs about 8 inches in diameter placed across the front, rear, and sides of the emplacement and embedded flush with the top of the ground help to make it tankproof. Upon the approach of tanks, the crew, without dismounting the weapon from the tripod, move it to the rear into the horseshoe trench and then crouch down to either side.

b. Three-fox hole type (fig. 41). The tripod legs for the heavy machine gun are reversed when the weapon is fired from the three-fox hole emplacement. This allows the gun to be mounted close to the gunner's fox hole, which is immediately behind the weapon. The assistant gunner occupies the fox hole to the left. The third fox hole remains unoccupied until it becomes necessary to fire the gun to the left, at which time the gunner and the assistant gunner shift to the right (counterclockwise). The spoil is piled all around the emplacement to form a parapet, care being taken to pile it so as to permit all-around fire of the weapon. When tanks appear about to overrun the position, the gun is

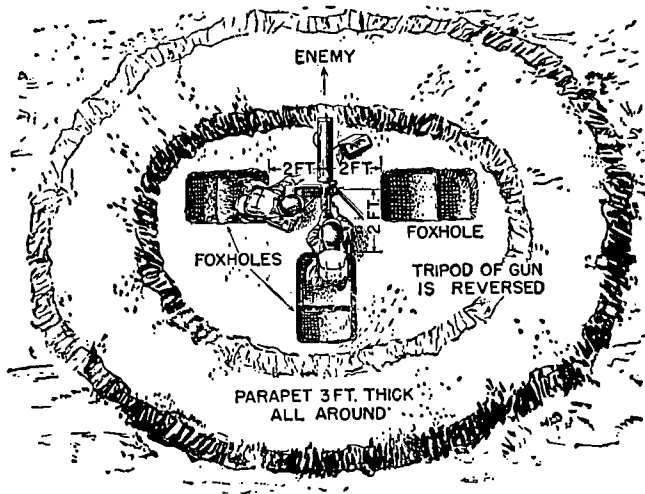


Figure 41. Three-fox hole type emplacement for caliber .30 heavy machine gun.



Figure 42. Hasty offensive emplacement for caliber .30 heavy machine gun.

dismounted from the tripod and the tripod is collapsed. One member of the crew takes the gun with him into his fox hole; the other takes the tripod. Figure 42 shows a hasty, offensive combat emplacement of the three-fox hole type for the caliber .30 heavy machine gun. Note that there is no parapet.

c. Comparison of combat types. In general, both the horseshoe-type emplacement and the three-fox hole type are satisfactory. As a firing position, the three-fox hole type is less flexible than the horseshoe type, but in some soils it may be more tankproof. The three-fox hole type has the advantage of using standard fox holes. However, the horseshoe type permits the gun to be restored more quickly to its firing position following a tank attack, since the gun remains on the tripod. For the latter reason, the horseshoe type generally is preferred for the heavy machine gun.

d. Antiaircraft type. The caliber .30 heavy machine gun, provided with elevator, is emplaced in a circular pit about 4 feet in diameter at the bottom, deep enough to provide protection and still allow the gun to engage ground targets (fig. 43). It is used only where defense against air targets is the primary consideration, as it does not provide the protection afforded by the horseshoe and three-fox hole types.

37. CONCRETE MACHINE-GUN EMPLACEMENT. The concrete machine-gun emplacement is a square concrete pillbox which has been used effectively in a theater of operations when time and materials permitted and a static front existed, and in deliberate defensive positions

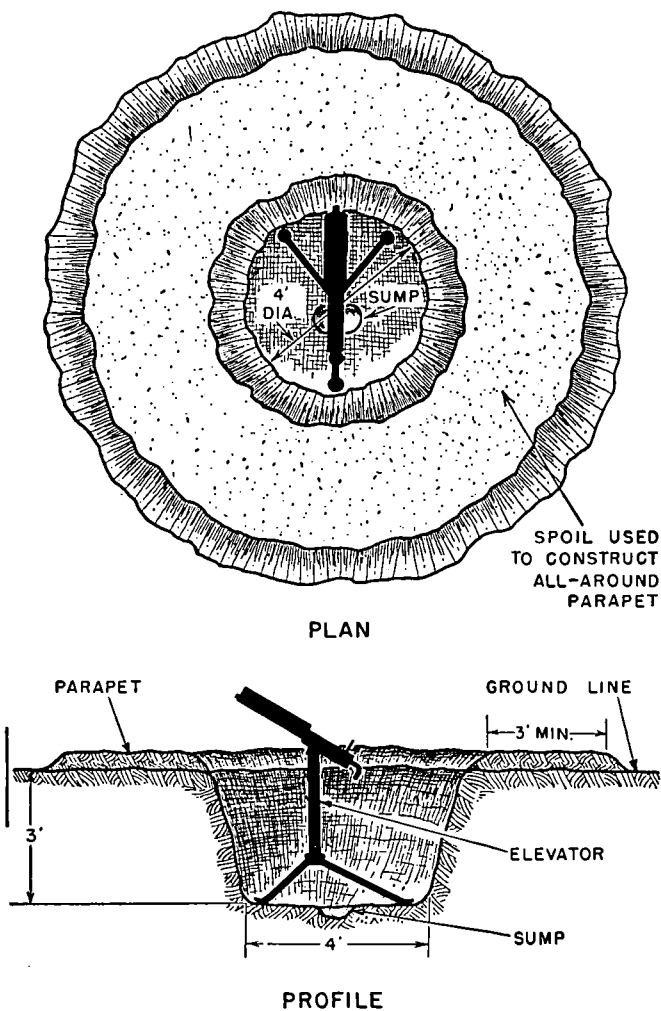


Figure 43. Antiaircraft emplacement for caliber .30 heavy machine gun.

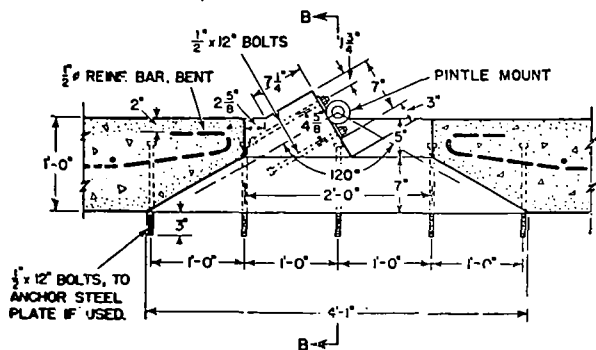
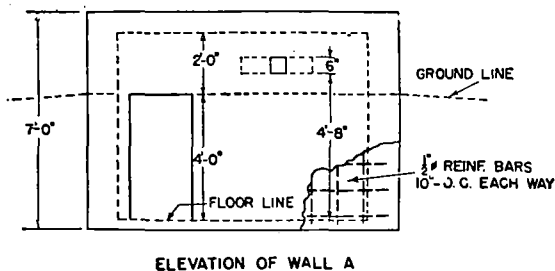
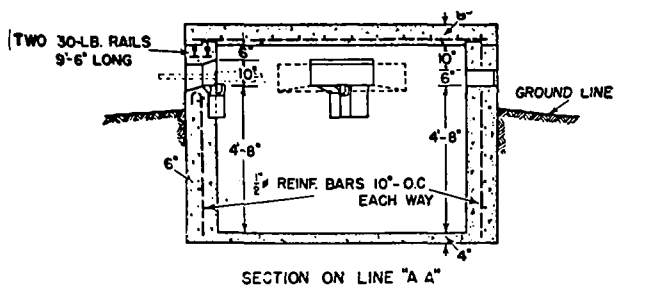
when an enemy invasion was anticipated. This type emplacement provides protection against bomb splinters, shell fragments, and small-arms fire. Embrasures not being used should be sandbagged from the inside or covered by steel plates bolted in place to give partial protection, allowing easy removal in case of an enemy attack from that direction. Either the light or heavy caliber .30 machine gun may be used in this emplacement, the light gun being preferred because its general size and shape permit a small embrasure. Figure 44 shows details of construction and table III gives the bill of materials required.

TABLE III. Bill of Materials for Square-Type Concrete Machine-Gun Emplacement

Item	Quantity
Concrete:	
(Cement)	11 cubic yards. (66 sacks).
(Sand)	5 cubic yards.
(Stone)	10 cubic yards.
Reinforcement:	
R. R. rails (30-pound) 9 feet 6 inches long	4.
Bars, ½ inch round, 9 feet 6 inches long...	54 pieces.
Bars, ½ inch round, 6 feet 6 inches long...	44 pieces.
*Bolts, machine, squarehead, with nut and 2 washers, ½ inch round, 12 inches long.	*20.

*If log-through-wall mounts are used, the following items are required.

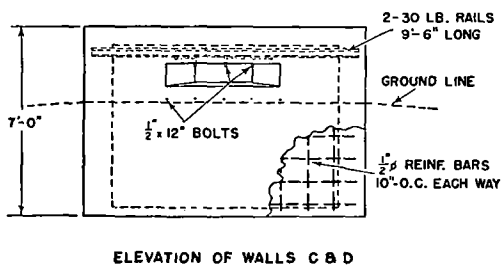
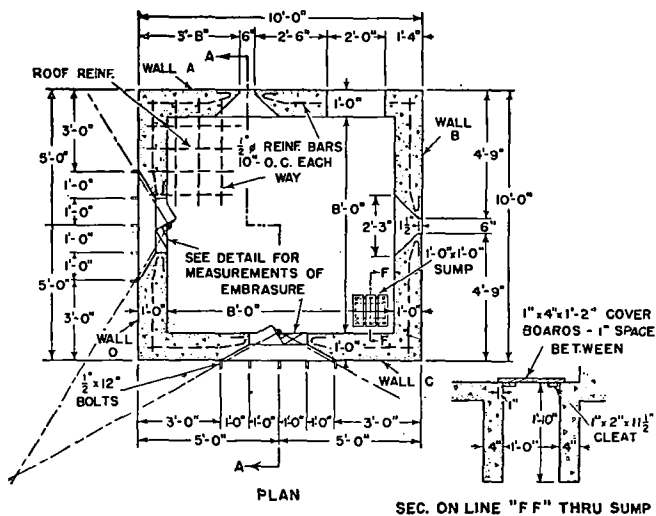
Bolts, machine, squarehead, with nut and 2 washers ½ inch round, 12 inches long.....	6
Steel plate, 3 inches by ½ inch by 3 inches.....	2
Steel plate, 4 inches by ½ inch by 1 foot 8 inches.....	2



PLAN OF EMBRASURE FOR CAL. 30 LIGHT MG

①

Figure 44. Plans for square-type concrete machine-gun emplacement.



EMBRASURE SHOWN IS FOR CAL. 30 LIGHT MG. OTHER TYPES MAY BE USED.
NUMBER OF EMBRASURES CAN BE VARIED.

④

Figure 44. Plans for square-type concrete machine-gun emplacement—Continued.

38. CALIBER .50 MACHINE GUN, M2, ON MOUNT M3. The emplacements for the caliber .50 machine gun, M2, on Mount M3, firing at ground targets, are essentially the same as those shown in figures 40 and 41. This is primarily an antiaircraft weapon but often may be used against ground targets.

39. 60-MM MORTAR EMBLACEMENT. a. Open Type (fig. 45). This consists of a rectangular pit (6 feet x 4 feet) large enough to accommodate the mortar, the gunner, and the assistant gunner. The emplacement is kept to the minimum size to afford protection against strafing and bombing and against artillery shells, but it allows room for firing the mortar and storing necessary ammunition. The front edge is sloped so the aiming stake, about 10 yards to the front, is visible through the sight and so the weapon's fire will be clear. The spoil from the excavation is piled all around the pit to form a low parapet. Fox holes for members of the mortar squad not required at the gun are prepared near the emplacement. Additional ammunition is placed in nearby shelters.

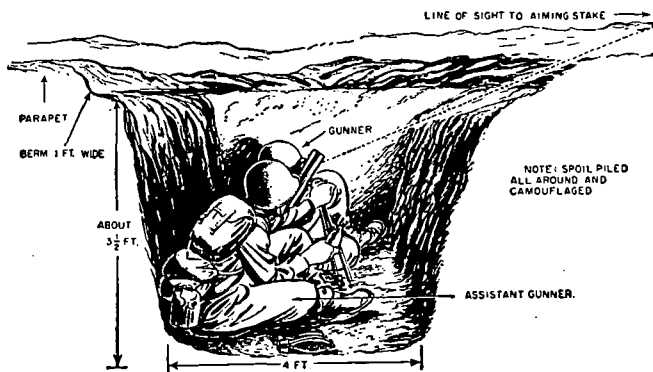


Figure 45. Open emplacement for 60-mm mortar.

b. Two-fox hole type. Figure 46 shows the 60-mm mortar in action, the crew operating from one-man fox

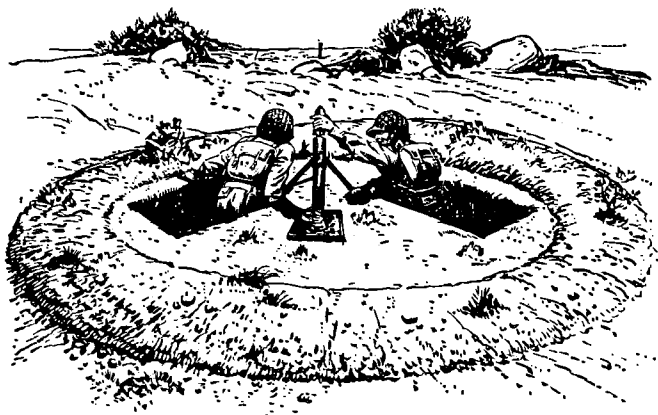


Figure 46. Two-fox hole emplacement for 60-mm mortar.



Figure 47. Hasty emplacement for 60-mm mortar.

holes. This two-fox hole type of emplacement is preferred when the mortar is in defilade. Figure 47 shows a hasty mortar emplacement of the two-fox hole type.

40. 81-MM MORTAR EMPLACEMENT. a. General. Except for somewhat larger dimensions, this emplacement (fig. 48) is the same as the open type described in paragraph 39 for the 60-mm mortar. A revetted ammunition niche may be built into the side of the pit.

b. Mortar emplacements in Arctic climate. In selecting a mortar position in Arctic climates, sufficient defilade should be secured to prevent disclosure of the position by the cloud of ice fog expelled when the mortar is fired.

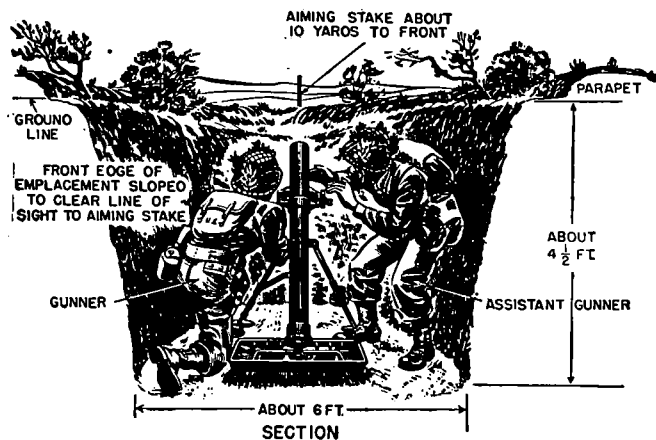


Figure 48. An 81-mm mortar emplacement.

41. CONCRETE MORTAR EMPLACEMENT. This deliberate emplacement (fig. 49), octagonal in shape, is sunk flush with the ground. It has recessed ammunition shelves in the walls and an underground ammunition

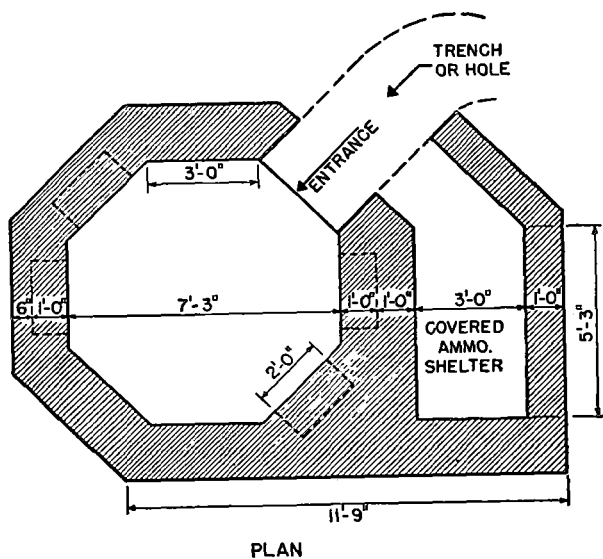
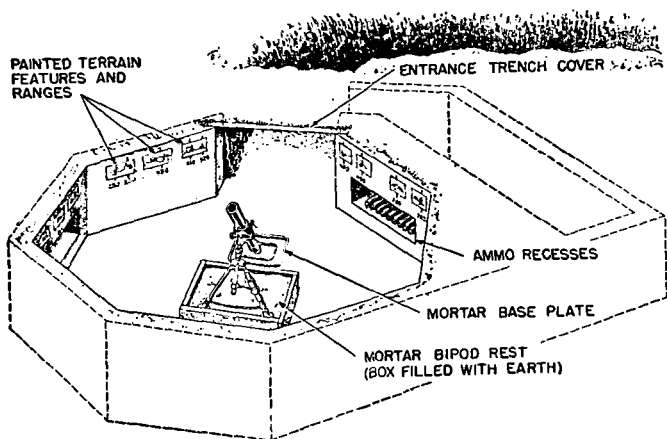


Figure 49. Concrete mortar emplacement.

shelter. Prominent terrain features with their respective ranges from the position are painted on the sides of the emplacement, taking the place of aiming stakes. The concrete mortar emplacement takes considerably less time and materials to construct than the concrete machine-gun emplacement. It has no roof but should have a camouflage cover or garnished net over it when not in use. This emplacement takes one-third as much concrete as the concrete machine-gun emplacement.

42. ROCKET LAUNCHER: Figure 50 shows a rocket-launcher crew preparing to fire from cover in the form of felled trees beside a road. This is an expedient emplacement. Defensive emplacements constructed for this weapon are the pit-fox hole type and the pit type.

a. **Pit-fox hole type** (fig. 51 ① and ②). This emplace-

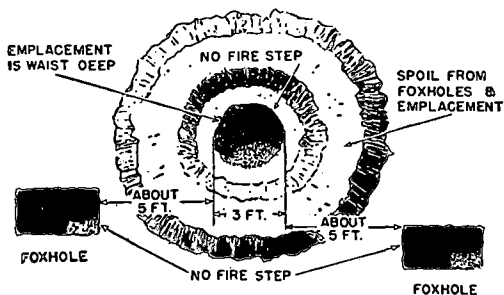


Figure 50. Rocket-launcher crew preparing to fire from roadside cover.

ment is a circular pit, 3 feet in diameter and about $3\frac{1}{2}$ feet deep, large enough for two men. It permits the assistant rocketeer to turn with the traversing weapon, so he is never behind it when it is fired. The emplacement is shallow enough to permit the rear end of the rocket launcher at maximum elevation to be clear of the parapet, thus insuring that the hot back-blast from the rockets is not deflected to the occupants. Since this emplacement is not tankproof, fox holes for the crew are dug nearby. *As the antitank mission of this weapon requires that it be kept in action against hostile tanks until the last possible moment, these fox holes will be occupied only when a tank is about to overrun the emplacement.*



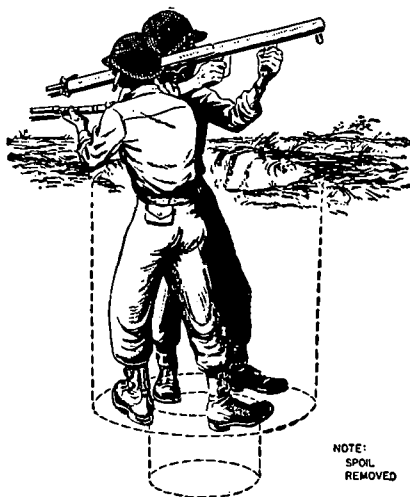
PERSPECTIVE VIEW



PLAN

① Dimensions of pit-fox hole type emplacement

Figure 51. Pit- and pit-fox hole type rocket-launcher emplacement.



② Pit-fox hole type emplacement



③ Pit-type emplacement

Figure 51. Pit- and pit-fox hole type rocket-launcher emplacement—Continued.

b. Pit type (fig. 51 ③). In firm soil, the diameter of the circular pit (fig. 51①) can be increased to 4 feet and an addition circular pit 2 feet deep and 2 feet in diameter excavated in the center. This leaves a circular fire step 1 foot wide and about $3\frac{1}{2}$ feet below the surface. When tanks appear about to overrun the position, the rocketeer and assistant rocketeer crouch down into the lower pit. When the tanks have passed, the rocket launcher is quickly returned to action.

43. 57-MM AND 75-MM RECOILLESS RIFLES. The four types of emplacements for the 57-mm and 75-mm recoilless rifle are the pit type and the two-fox hole type for the 57-mm rifle, the horseshoe type which may be used for both rifles, and the trapezoidal type for the 75-mm rifle only.

a. Pit type. This emplacement is the same as the pit-type rocket-launcher emplacement (fig. 51 ③). It is designed for shoulder firing from the standing or kneeling position.

b. Two-fox hole type. This emplacement (fig. 52) is designed to provide adequate protection for the crew when firing the 57-mm rifle from a tripod. The gunner occupies the hole on the left and the assistant gunner occupies the hole on the right of the gun. When tanks are about to overrun the position, the gun is dismounted and the tripod is collapsed.

c. Horseshoe type. This emplacement (fig. 53) is constructed by digging out a horseshoe-shaped trench about 2 feet wide along the sides and 3 feet wide along the front of the proposed location of the tripod, leaving a waist-high gun platform to the center and rear and

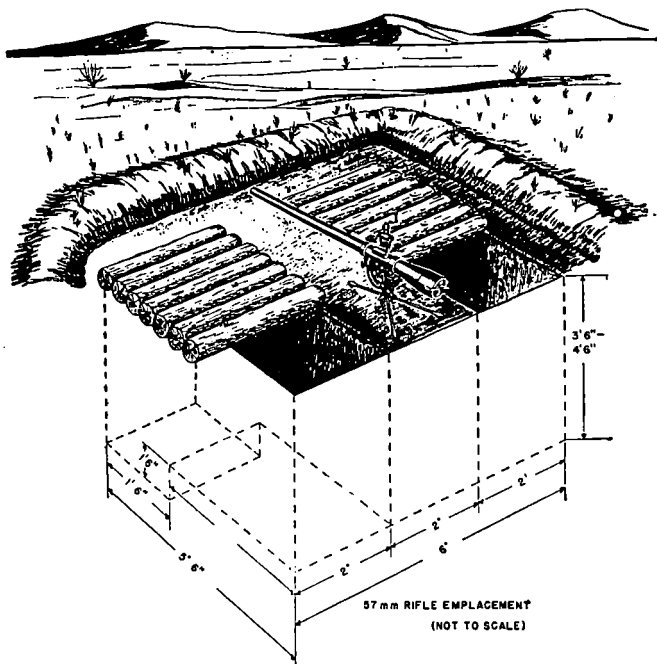


Figure 52. Two-fox hole type 57-mm recoilless-rifle emplacement.

about 1 to 1½ feet below the ground level. All spoil is removed. When the emplacement is on a forward slope, or when the maximum elevation at which the gun is to be fired is such as will cause the projection of the axis of the bore to pass less than 8 inches above the top of the back wall of the emplacement, the upper part of the back wall must be beveled back about 3 feet so the back-blast deflects to the rear and not down into the emplacement. If the position is about to be overrun by tanks, the gun can be dismounted and taken into the

emplacement. In most types of soil, tanks can run over this emplacement without destroying it, the weapon, or occupants. In loose soil, logs about 8 inches in diameter placed across the front, rear, and sides of the emplacement and embedded flush with the top of the ground, help to make it tankproof.

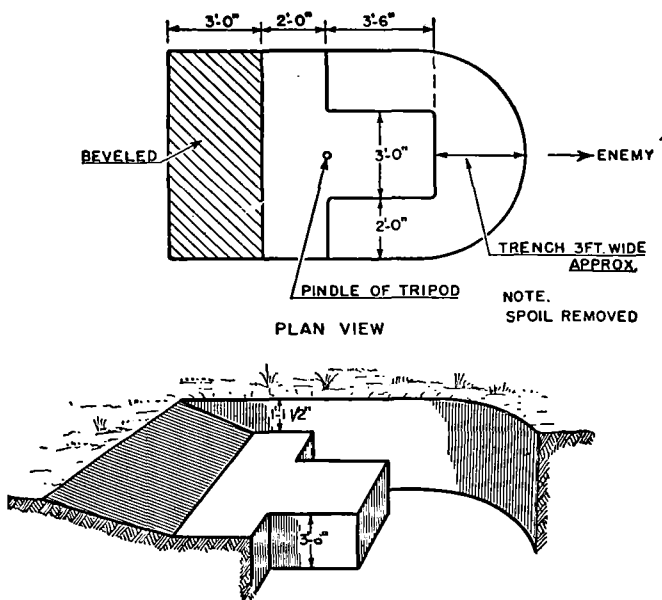
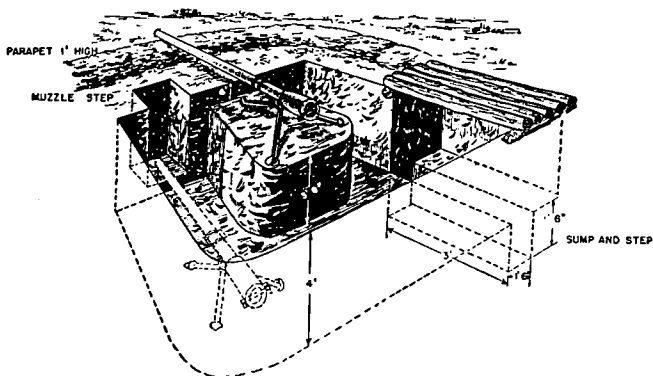
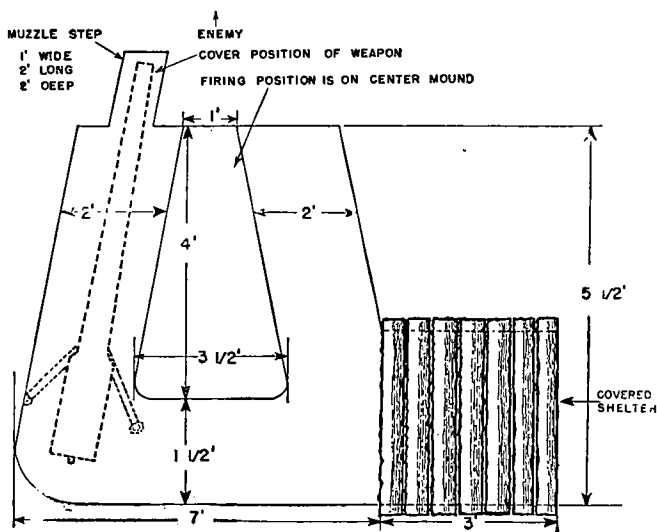


Figure 53. Horseshoe-type emplacement for 57-mm and 75-mm recoilless rifles.

d. Trapezoidal type. The trapezoidal-type emplacement (fig. 54) consists of a pit 4 feet deep, 7 feet long at the rear, 5 feet long at the front, and 5½ feet wide. A covered shelter for the crew, 3 feet square and 4 feet deep, is dug into the right rear side of the emplacement. When the emplacement is excavated, a firing platform



① Isometric view.



② Plan view.

Figure 54. Trapezoidal-type emplacement for 57- and 75-mm recoilless rifles.

3½ feet high, 4 feet long, and tapering from 3½ feet in width at the rear to 1 foot at the front is left as shown in figure 54 ①. A muzzle step is excavated in the front left side of the emplacement on which the muzzle of the rifle is rested in the position shown in figure 54 ①, when the rifle is not in firing position. From this emplacement, the rifle may be fired in a 360-degree traverse without difficulty.

3. **Comparison of combat types.** In general, all four types of emplacements are satisfactory. The pit type and trapezoidal type offer greatest flexibility of fire. Of these two types, the trapezoidal permits more accurate delivery of fire because firing is done from the tripod. The two-fox hole type is very limited in sector of fire, but has the advantage of simplicity of construction and is more tankproof than the other types. The horseshoe type normally is an intermediate step between the two-fox hole and trapezoidal types.

44. SELF-PROPELLED WEAPON EMPLACEMENTS.

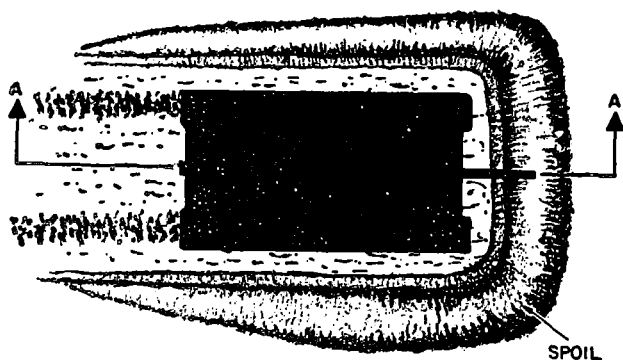
a. **General.** Self-propelled guns of large caliber have very limited traverse without turning the vehicle and it is therefore seldom practicable to construct emplacements for such weapons. This paragraph is a guide for constructing protective work for self-propelled weapons mounted in a revolving turret. Such construction takes several hours. Whenever possible and for purposes of secrecy, new positions are constructed and occupied during darkness, all camouflage being completed before dawn. Reconnaissance frequently discloses natural defilade such as sunken roads or ditches which, with minor improvement, make excellent positions because supplementary positions are usually available within the

same natural cover. The following steps give the general procedure to be followed in fortifying a position:

- (1) Emplace self-propelled weapon ready for firing as soon as possible. If position is to be excavated, place the vehicle off to one side of the final position.
- (2) Dig special trenches near the emplacement for personnel, preferably on the rear side where dismounted personnel will be shielded by the vehicle.
- (3) Provide hasty camouflage if working in daytime.
- (4) Make necessary excavation at final position. This can be done easily by a bulldozer, if available. If not, it will have to be done by hand.
- (5) Emplace weapon in final position and put in firing order.
- (6) Continue to build up and fortify the position as time permits.

b. Construction of emplacements. While it is desirable to give every protection to personnel and equipment, the prime consideration always must be the efficient use of the weapon. Emplacements for self-propelled weapons may be either the built-up or dug-in type. A dug-in type emplacement (fig. 55) should conform to the following standards:

- (1) An excavation deep enough to afford proper protection for the hull of the self-propelled vehicle; maximum spoil to be placed on the front of the emplacement with some on the sides; rear left open for entry or exit of vehicle.



PLAN VIEW



SECTION A-A

CAMOUFLAGE NOT SHOWN

Figure 55. Dug-in emplacement for self-propelled weapon.

- (2) Inside dimensions just large enough to permit entry and exit of vehicle.
- (3) An inside depth permitting the weapon to depress to its minimum elevation.
- (4) Barrel stops, if necessary, to prevent fire into adjacent units.
- (5) Provisions for drainage, if possible.

- (6) When fire must be delivered at elevations higher than the maximum permitted by the design of the carriage, it may be necessary to construct the emplacement with its entrance at the front and the floor sloping to the rear. The carriage then is backed into position. The entrance may be closed temporarily by sandbags.

c. Shelters. Normally the crew will be protected when they are inside the vehicle. However, it may be advisable to construct a special shelter in the immediate vicinity of the emplacement where crew members would be protected when they are not in the vehicle. The shelter may be connected to the emplacement by a trench. Another type shelter can be dug under the weapon. In such a case, adequate and rapid means of egress must be provided to enable the occupant to escape quickly in case fire occurs in the carriage.

SECTION IV. TRENCHES

45. Connecting Trenches. a. Although connecting trenches (fig. 56) are conspicuous to aerial observers, they are dug when the improved protection, control, communications, and supply outweigh the need for concealment. A few short trenches sometimes are dug in inconspicuous places to permit necessary daylight movements across exposed areas, particularly after positions have been revealed beyond question. Necessary connecting trenches also may be dug in close country, such as jungle, where their position probably will not be disclosed. Connecting trenches average 2 feet in width and

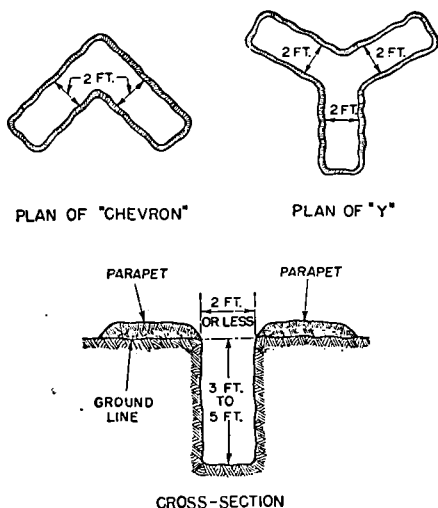
1 to 1½ feet in depth; they require about 2 cubic feet of excavation per foot of trench. With a parapet about 9 inches high, they provide cover for a man crawling on his hands and knees.



Figure 56. A squad moving along a connecting trench across open ground which is under enemy fire.

b. In areas where there is deep snow, connecting trenches may be tunneled under the snow. (See par. 47e)

46. SPECIAL TRENCH. a. **Purpose.** To meet the needs of the field artillery, the special trench (fig. 57) has been developed. When several men must be provided protection within a limited area, special trenches frequently are used because they take less space than fox holes. Because they are also especially suitable for use under a camouflage net, they normally are con-



NOTE: LEGS OR BAYS ARE 6 FT. OR LESS IN LENGTH

Figure 57. Cross-section and typical plans of a special trench used with artillery emplacements.

structed and occupied by artillerymen and by personnel at rear installations.

b. Construction. The special trench is 2 feet wide, or less, and from 3 to 5 feet deep. It is dug in short lengths, in the shape of a chevron, a Y, or any other trace which fits into the space available. Changes in direction are made to reduce the effects of bombs, artillery shells, or aerial strafing.

47. STANDARD TRENCH. a. Purpose.

- (1) The standard trench (fig. 58) offers much less protection, is harder to conceal, and re-

quires more time and labor to construct than fox holes. However, it improves communication, control, supply, and evacuation. The use of trenches is a command decision. Standard

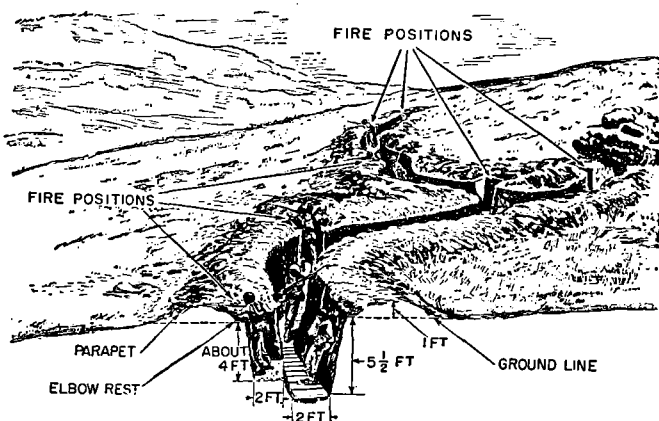


Figure 58. Standard trench.

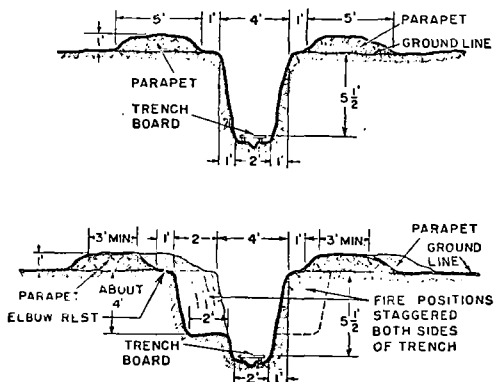


Figure 58. Standard trench—Continued.

trenches might be used to advantage in the following situations:

- (a) Communication trenches in stabilized situations when either concealment is available or the advantages to be gained justify exposure.
- (b) Entrances to shelters or groups of shelters.
- (c) Operations in extreme cold, when the soldiers, who remain in heated shelters until the last minute, must be able to get to firing positions under cover.
- (d) In jungle and forest warfare, when movement of tanks is impossible or very restricted and when there is concealment from

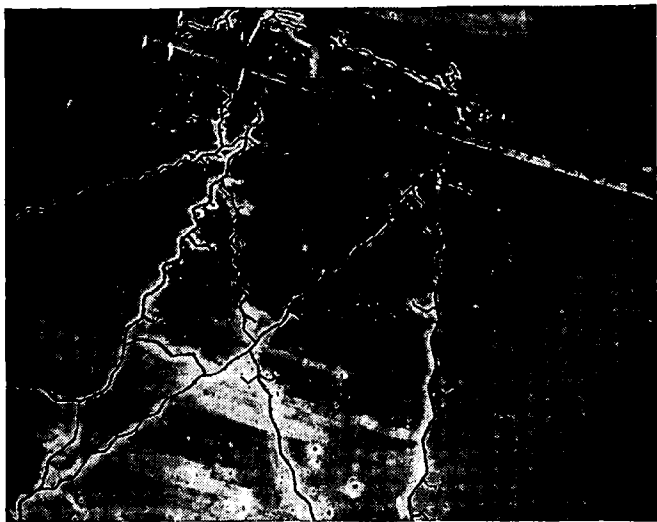


Figure 59. Network of standard trenches.

all types of enemy observation, particularly aerial photography.

- (2) Figure 59 shows a network of standard trenches. Shelters and gun positions are located at the ends of the short branches off the main trench lines.

b. Construction. The standard trench is 4 feet wide at the top, 2 feet wide at the bottom, and $5\frac{1}{2}$ feet deep. The spoil is used to construct an irregular parapet 3

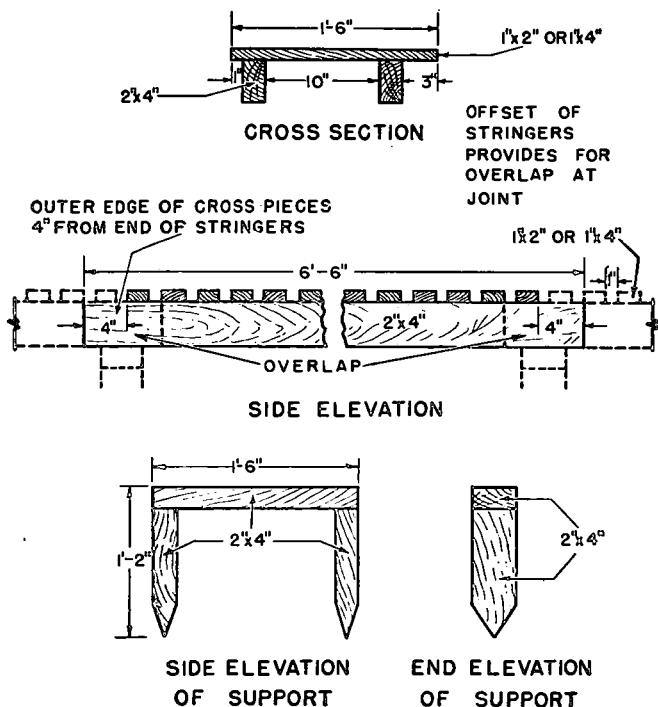


Figure 60. Details of trench board and support.

feet wide on each side of the trench. To reduce the number of casualties likely to occur from one enemy bomb or shell exploding in the trench and to aid in concealment, the trench is irregular in plan and is built in short sections. Trench boards (fig. 60) should be installed in all standard trenches. Lumber or cut timbers may be used. The trench is deepened so the top of the trench board is $5\frac{1}{2}$ feet down, and the bottom of the trench is shaped into a trough for drainage. In soft ground, supports for flooring are required.

c. Fire Positions. The standard trench is used either as a fire or communications trench. Fire positions (fig. 58) are staggered 5 to 10 yards apart on both sides of the trench. They are dug 2 feet wide, $2\frac{1}{2}$ feet into the trench wall, and deep enough so the ground line is chest high. Fire positions are constructed in all standard trenches both to increase combat effectiveness and to prevent the enemy from distinguishing between fire and communication trenches.

d. Winter trenches.

- (1) When constructing trenches in ground which is not frozen to a great depth, the following practice is adopted when the tactical situation permits unimpeded work: To avoid the labor of digging through frozen ground, the surface is divided by furrows into the desired sections. These sections then are undermined, and the frozen crust is caved in and removed. For this work, heavy pickaxes, crowbars, iron wedges, and the like are necessary. Deeply frozen ground can be broken up by engineers, using power drilling equipment (concrete

breakers driven by portable compressors), blast-driven earth rods, and explosives. Holes for explosives can be made in frozen ground by driving in red-hot, pointed, iron rods or crowbars. When excavating trenches in deeply frozen ground, the best method is to dig holes, at intervals of several feet down to the full depth of the trench. These holes then are connected by tunnels under the frozen surface; finally, the surface is caved in.

- (2) Trenches may be covered over to prevent them from becoming filled with snow and to conceal them. (See figs. 61 and 62.) The cover (round timbers, cut timbers, planks, beams, or sheet metal) must be strong enough to carry the maximum weight of snow that can be expected. Fire positions may be left open or covered with an improvised, easily removable lid such as is shown in figure 29. If the snow is very deep, the actual digging into the ground may be much less than that necessary in snow-free terrain. However, sandbags should be piled on the enemy side of the trench from ground level to a height of 6 feet above the trench board.

e. Tunneling in snow. If the snow is deep enough, tunnels can be constructed easily. They do not provide effective protection against artillery fire, but this disadvantage is considerably outweighed by the complete concealment they afford. The method of construction varies according to the condition of the snow, which may be either fresh powdery snow or crusted-over old snow of

varying depths. The following are the methods employed:

- (1) Dig in from the surface and cover over with planks and layers of snow.

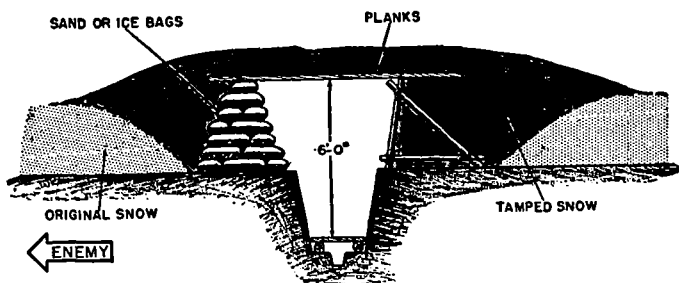


Figure 61. Covered winter trench.

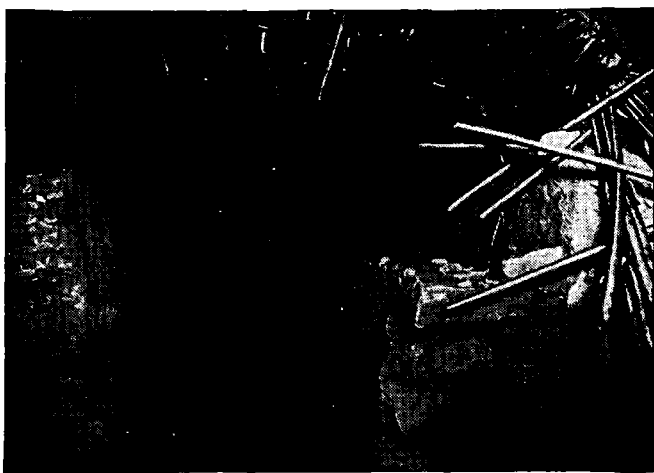
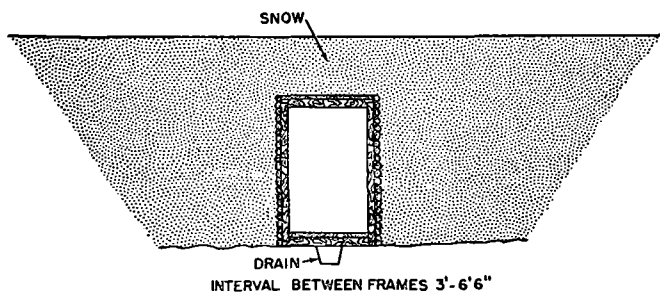
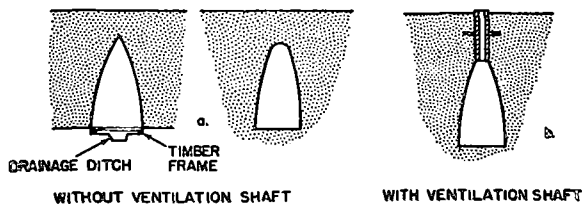


Figure 62. Interior of a covered trench.

- (2) Dig in from the surface and construct sheeting or revetting with planks, beams, brushwood, or sheet-iron.
- (3) Dig underground tunnels (fig. 63); construct wooden sheeting or revetting with planks, beams, or brushwood.
- (4) Construct tunnels without sheeting. In long tunnels, ventilation must be provided by ventilation shafts (fig. 63).



① WITH SHEETING. (TIMBER, PLANK, BRUSH, SHEET METAL, ETC.)



② WITHOUT SHEETING.

Figure 63. Snow tunnels.

Section V. FIELD ARTILLERY EMPLACEMENTS

48. GENERAL. a. The purpose of field artillery field fortifications, like that of infantry emplacements, is to provide protected firing positions for weapons and cover for gun crews and ammunition supplies. Field artillery emplacements are much larger than those constructed by the infantry and require more time and labor to excavate.

b. These fortifications are designed to—

- (1) Permit delivery of fire within prescribed zones.
- (2) Permit direct (flat trajectory) fire against tanks.
- (3) Utilize existing ground formations to lessen labor.
- (4) Take advantage of natural cover and concealment.
- (5) Allow rapid movement of a weapon to an alternate position.
- (6) Protect personnel from enemy artillery and bombing.
- (7) Allow simplicity of construction with a minimum of labor and time.
- (8) Provide comfort during prolonged occupation.
- (9) Allow for continuous improvement with tools and materials available.

c. Fortifications are begun as soon as practicable after positions have been selected. It should not be assumed that occupation of a position may be so brief that fortifications are unnecessary; however, the opening of fire must not be delayed by the construction of fortifications.

49. PRIORITY OF CONSTRUCTION. a. On going into position, fortifications are constructed to gain the following results, listed in order of priority:

- (1) Ability to deliver fire on time.
- (2) Protection of personnel and ammunition.
- (3) Concealment.
- (4) Alternate firing positions.

b. The following is an example of the procedure followed by a 105-mm howitzer section in daylight occupation of a previously selected position:

- (1) Place the piece in firing position so that it may accomplish its mission; lay the piece and otherwise prepare to execute fire missions. Concealment is taken into account in selecting the position and is maintained continuously.
- (2) Dig entrenchments for personnel and shelters for ammunition.
- (3) Construct necessary camouflage.
- (4) Repeat above procedure for alternate positions.

c. When preparing the weapon emplacements, make full use of explosives and any power equipment available (such as bulldozers) unless nearness of the enemy demands quiet. (See figs. 3 and 64.)

50. PROTECTION FOR PERSONNEL. Standard types of infantry entrenchments are employed for protection against aerial and artillery bombardment as well as possible ground attack.

a. Personnel at supply points, in bivouacs or assembly areas, and at installations other than gun emplacements are best protected in fox holes (pars. 25, 26, and 27) or prone shelters (par. 88).

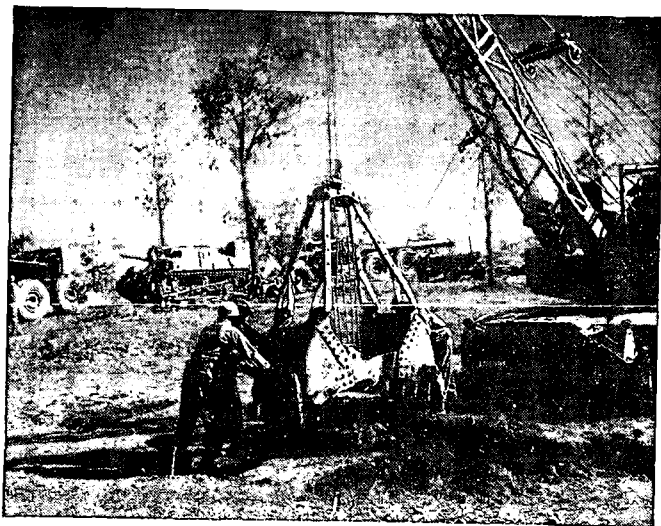


Figure 64. Crane with clamshell attached excavating a position for a 240-mm howitzer.

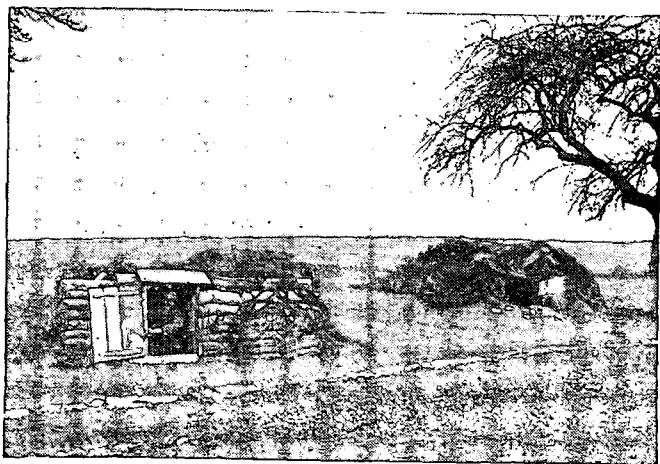


Figure 65. Partially dug-in personnel shelters.

b. Personnel at gun emplacements may use special trenches (par. 46).

c. Observers occupy modified fox holes or covered observation posts (par. 31).

d. In stable situations, protection of personnel may be increased by construction of any appropriate shelter, as described in detail in chapter 3. Figure 65 shows two personnel shelters, partially dug in and camouflaged. Note sandbags and scrap material used in their construction.

51. AMMUNITION SHELTERS. The construction of ammunition shelters begins as soon as the battery has prepared for firing and is concealed. Shelters are so located and constructed that they protect ammunition against the weather and enemy fire, are well concealed, and are large enough to hold the desired quantity of ammunition close to the firing position. Projectiles, powder charges, fuses, and primers are each stored in separate shelters. There are at least two shelters for each component, separated so a direct hit can not destroy the entire supply of any one item. The protection required for the several components of separate loading ammunition is the same as for complete rounds of fixed or semi-fixed ammunition. The following methods are employed.

a. Initially, or when ground conditions limit excavation, ammunition is placed in natural depressions and dispersed in relatively small quantities.

b. It sometimes may be necessary to construct ammunition shelters above ground, particularly when the water level underground is close to the surface. Such shelters may be formed by constructing a log crib around the ammunition and building up with earth

around the crib. Powder cases filled with dirt may be used as a substitute for logs.

c. Pits may be hastily dug and branches or rocks placed at the bottom to prevent contact of ammunition with wet earth.

d. Time permitting, appropriate shelters may be constructed. Representative shelters for 105-mm and 155-mm ammunition are shown in figures 66 to 70. For further data concerning storage and protection of ammunition in the field, see FM 6-140.

- (1) *Shelters in parapet of emplacement.* Shelters constructed and concealed in emplacement parapets (figs. 66 and 67) are convenient for ammunition handling, inconspicuous, and keep ammunition dry.



Figure 66. Ammunition shelter in parapet.

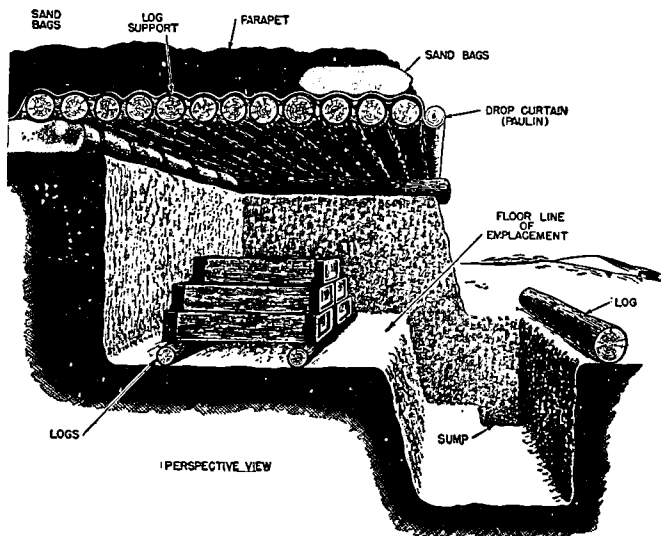


Figure 67. Ammunition shelter in parapet with handling pit.

(2) *Open-pit type.* This shelter (fig. 68) consists of a pit for handling and a shelf for stocking ammunition. Similar shelters may be used in battery dumps.

(3) *Concrete type.* This type of shelter (fig. 69), used for any size ammunition, may be constructed in deliberate positions where time and materials are available.

(4) *Covered type.* This type is made of logs, sod, dirt, and other expedient materials. It may be used as an ammunition shelter or a personnel shelter. (See fig. 70.)

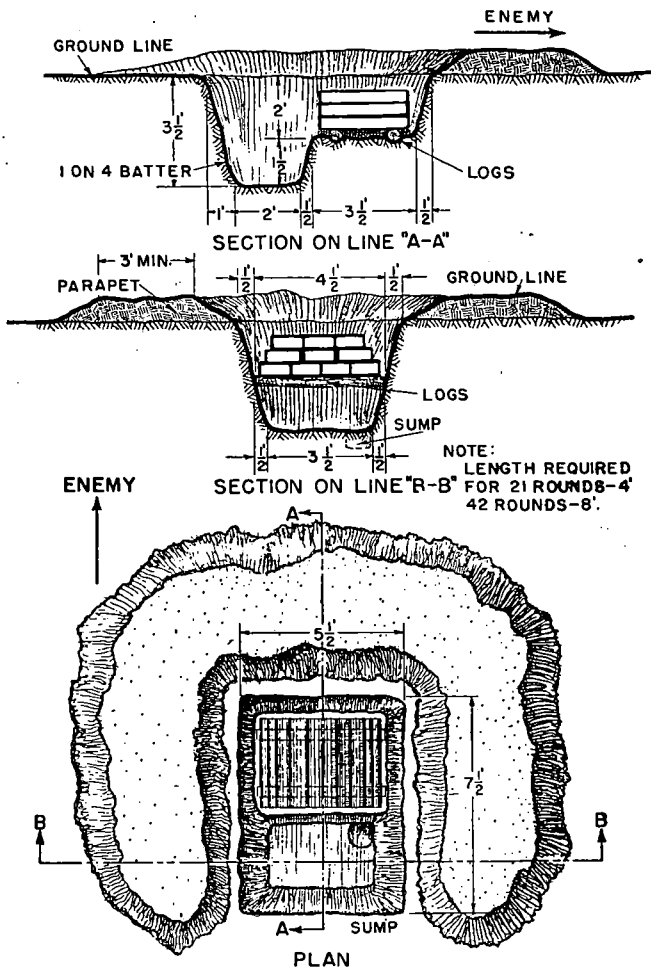


Figure 68. Open-pit type ammunition shelter.

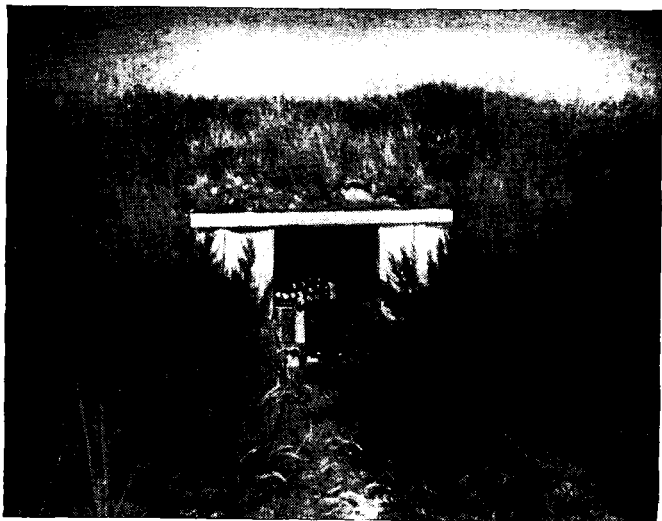


Figure 69. Concrete ammunition shelter.



Figure 70. Covered ammunition shelter.

52. EMBLEMMENTS FOR 105-mm AND 155-mm HOWITZERS. Standard emplacements for all models of 105-mm and 155-mm howitzers are constructed so the same emplacement is suitable for any of these weapons. There are two standard emplacements for these weapons, the surface type and the 24-foot diameter pit type.

a. Surface-type emplacement (fig. 71). This consists of a built-up parapet of earth or sandbags in front of the piece, an ammunition pit on its left side, and special trenches to accommodate the gun crew. Normally, special trenches are constructed for six men on the left of the piece and for two men on the right.

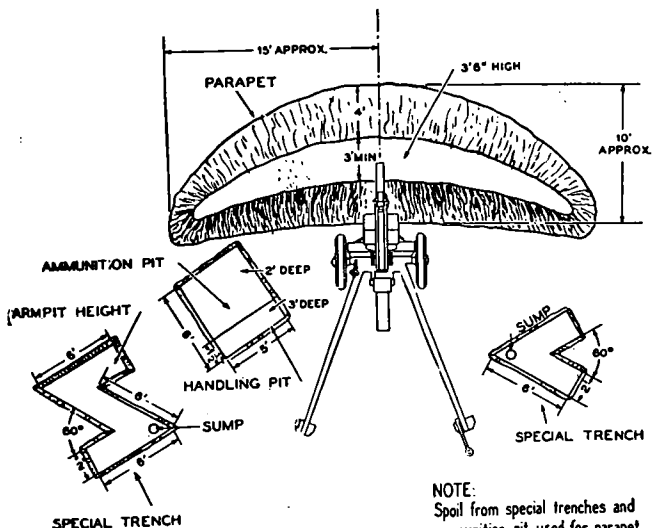
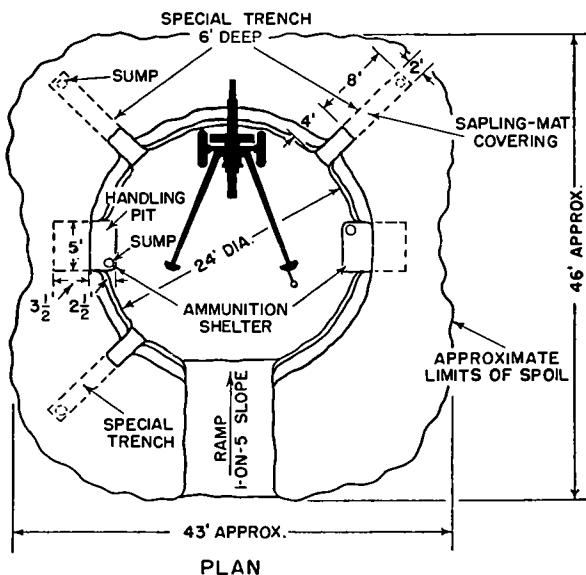


Figure 71. Surface-type emplacement for 105-mm and 155-mm howitzers (all models).

b. 24-foot-diameter pit-type emplacement (fig. 72). This consists of a circular pit, about 2 feet deep and 24 feet in diameter, with a sloping ramp at the rear to permit moving the piece into and out of the emplacement. The emplacement is surrounded by a parapet approximately $1\frac{1}{2}$ feet high, except at the ramp which is left open to allow rapid withdrawal of the piece. Ammunition shelters of the type indicated in paragraph 51 are located in the parapet on either side of the piece. To save time and extra digging, covered special trenches are dug under the parapet either before or along with construction of the main pit. Spoil from the main pit, ammunition shelters, and special trenches is used to build the parapet.

53. EMPLACEMENTS FOR HEAVY ARTILLERY. Emplacements for the 8-inch howitzer, the 8-inch gun, and the 240-mm howitzer are similar to those for the 155-mm gun. (See fig. 73.) The outline of the emplacement is marked out on the ground, as shown in the figure, with the emplacement center line along the direction of fire of the piece. Direction of fire must be surveyed and marked before lay-out and construction of the emplacement are started. If it is necessary to cover a zone of fire greater than that provided by the traverse of the piece, the emplacement must be modified to permit shifting of the trails. Figure 74 shows a 155-mm gun in action from a camouflaged pit-type position.

54. EMPLACEMENT FOR 240-mm HOWITZER. Many soil conditions make it impractical to dig this weapon in below ground level. The type of emplacement shown in figure 75 is used only in cases where the weapon is left in position for several months or longer. Normally,



NOTE:

BY PULLING THE WEAPON TO THE REAR UNTIL THE AXLE IS IN THE CENTER OF THE EMPLACEMENT, THE WEAPON MAY BE SWUNG AROUND TO FIRE TO THE REAR OR IN ANY DESIRED DIRECTION (FOR ALL-AROUND DEFENSE).

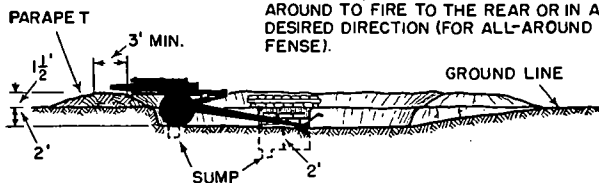


Figure 72. The 24-foot-diameter pit-type emplacement for 105-mm and 155-mm howitzers.

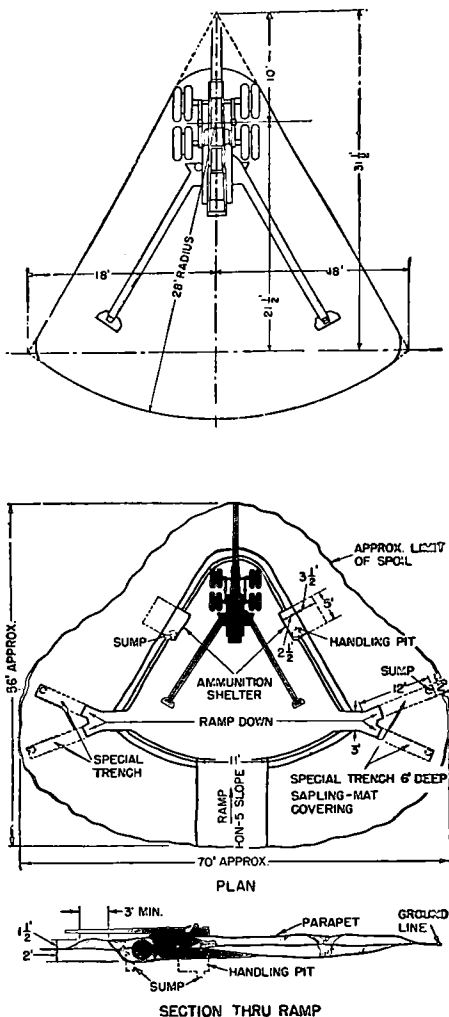


Figure 73. Emplacement for 155-mm gun M2 and similar heavy artillery.



Figure 74. A 155-mm gun in action.

due to the size of the weapon, the great number of sandbags required, and the method of employment, this weapon would be emplaced at ground level and camouflaged with naturally or artificially garnished nets or natural cover.

55. TRAIL SUPPORTS. a. Trail logs facilitate traversing the 105-mm howitzer beyond its normal limits and are especially desirable if large shifts or all-around fire is necessary. This support is provided by placing a large log or timber under the float and in rear of the spade, perpendicular to the trail. The timber should be 8 inches or more in diameter, and about 6 feet long.

b. During continuous firing in wet or soft ground, the 155-mm howitzer, the 155-mm gun, and the 8-inch howitzer usually require trail support in addition to that

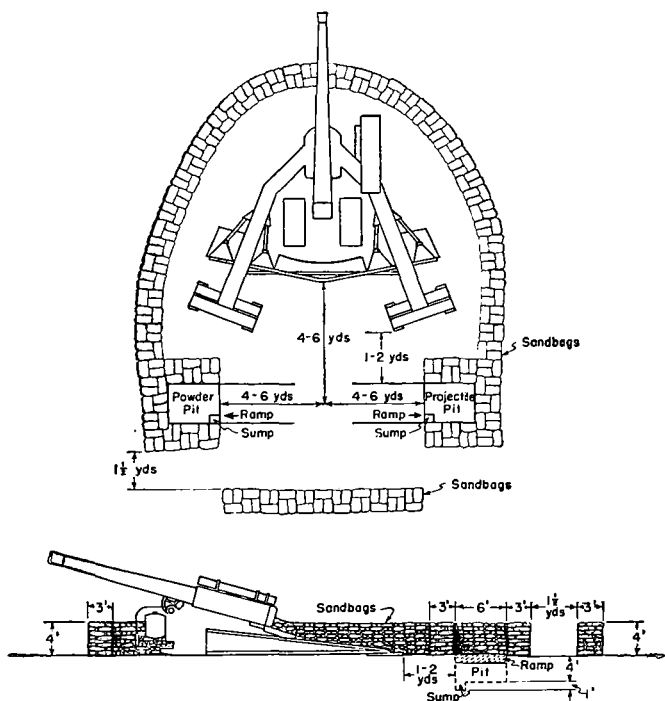


Figure 75. Emplacement for a 240-mm howitzer.

afforded by the trail spades. This support is provided by placing a large log or timber under the shoe perpendicular to each trail. The timber should be 12 inches thick and 12 feet long, extend 6 feet on each side of the spade, and be flush with the ground surface.

56. WEAPON PLATFORM. If timber is available, an improvised log platform may be constructed by burying three or four sills in the ground parallel to the direction of fire, and laying a row of *straight* logs upon them at

right angles. These can be held in place by wiring or spiking the top layer to the sills, or by covering the entire platform with 6 inches of earth. The top of the completed platform should be flush with the ground on either side. (See fig. 76.)

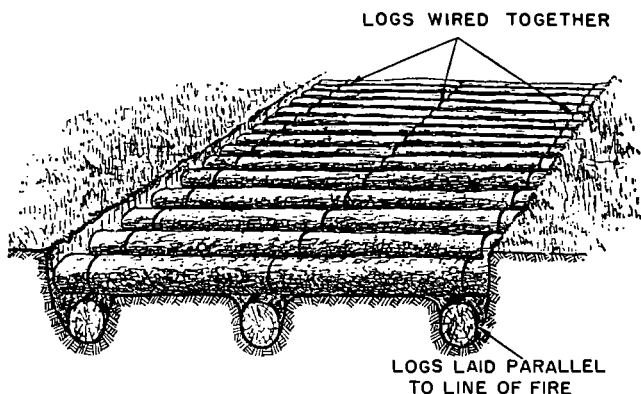


Figure 76. Timber platform for heavy artillery.

Section VI. SEACOAST ARTILLERY EMPLACEMENTS

57. ALL-AROUND FIELD-OF-FIRE EMPLACEMENT FOR 155-mm GUN M2, USING FIRING PLATFORM M1.

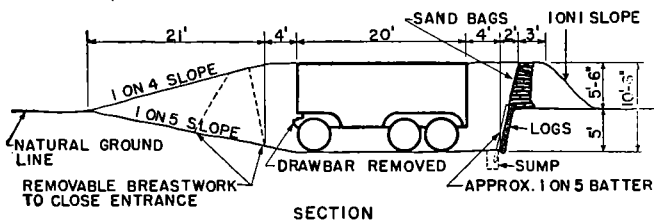
a. This emplacement (fig. 77) consists of a circular pit about 48 feet in diameter and 2 feet deep with a ramp for rapid emplacement and removal of the piece. The excavated spoil is used to construct a parapet about $2\frac{1}{2}$ feet high around the emplacement. The firing platform M1 is emplaced on the bottom of the pit. When the emplacement is constructed as shown in figure 77, the projectile fired by the gun at minimum elevation of

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•



(2) *Second stage.* The parapets are revetted, if necessary, and the ramp is closed off with sandbags or other readily removable material.



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58. EMPLACEMENT FOR AN/MPG-1 TYPE RADAR OR M8 SERIES DATA COMPUTER.

a. This emplacement (fig. 78) is a rectangular pit 24 feet long, 14 feet 2 inches wide, and 10½ feet deep from the top of the parapet. A ramp is constructed at one end of the pit for installing and removing the radar or computer.

b. When constructing this emplacement, the pit and ramp are excavated, using the spoil as a parapet. The parapet then is revetted, if necessary, and the ramp closed off.

c. If time permits, the emplacement for the computer should be covered by placing logs, timbers, or other available material over the pit. Sandbags placed on top of the semitrailer help absorb fragmentation from airbursts.

Section VII. ANTI-AIRCRAFT ARTILLERY EMPLACEMENTS

59. GENERAL. **a.** This section is a guide for constructing protective works for anti-aircraft artillery, equipment, and personnel. Paragraphs 63–72 describe emplacements for battery guns and supplementary equipment; paragraphs 73–76 describe emplacements for automatic anti-aircraft weapons. No matter how short a time a position is expected to be occupied, fortifications should be constructed rapidly. However, fortification construction should not have priority over readiness to fire the weapon. Whenever possible, new positions are occupied during darkness. Camouflage should be completed before dawn. Careful planning saves time and labor in

preparing the fortification. The following outline indicates the general procedure to be followed in fortifying a position:

- (1) Have equipment ready for firing as soon as possible. If the position is to be excavated, equipment is placed in operating positions to the side of emplacement site.
- (2) Dig fox holes or prone shelters for the personnel near or as part of the emplacement.
- (3) Provide hasty camouflage if working in daytime.
- (4) Make necessary excavation at final position.
- (5) Emplace equipment in final position with minimum interference to firing readiness and put it in firing order.
- (6) Continually improve the position by building up and fortifying as time permits.

b. The cut-and-fill method of fortification described in section V, this chapter is the most economical and should be used wherever conditions of drainage and subsurface water level permit.

c. Explosives may be used to facilitate excavation in hard or frozen ground. Only qualified technicians should be permitted to supervise the use of explosives because of the potential danger to personnel and equipment. Earth-moving equipment, such as bulldozers, save much time and labor and should be used for excavating and building up parapets when available.

d. Close the entrance with a removable blast wall. For this purpose, use materials which can be removed

quickly, such as sandbags. When using logs or soil-filled ammunition boxes, they should be lined with sandbags to minimize danger from splintering.

60. REQUIREMENTS. While it is desirable to give every protection to personnel and equipment, the primary consideration must be the efficient use of the equipment. A typical fortification has the following features:

a. A parapet at least 3 feet wide at the top (with its outside slope from 30 to 45 degrees) surrounding the emplacement. The height of the parapet is that which gives maximum protection yet permits the equipment to be operated against any expected air, land, or sea target within the equipment's effective range. For concealment purposes, the parapet must be as low as possible, the necessary inside height of the emplacement being obtained by excavation.

b. A minimum inner diameter permitting efficient operation. The inside slope of the parapet should be as steep as the nature of the soil and revetting materials permit, preferably a slope of 12 on 1. The muzzle of the gun must extend over the parapet to minimize danger from muzzle blasts.

c. An inside depth permitting the gun or instrument to depress to its minimum elevation. When only aerial targets are expected, the parapet may be built at least to trunnion height.

d. Removable barrel stops to prevent accidental firing into friendly units or installations.

e. Provisions for drainage of the emplacement.

61. PROTECTION FOR PERSONNEL. Protection is required against shell and bomb fragments, ground fire, and strafing. Normally, fortifications for the equipment also will provide sufficient protection for antiaircraft artillery personnel, but when additional protection is advisable, it is obtained by digging conveniently located fox holes or special trenches.

62. AMMUNITION SHELTERS. a. Some ammunition is stored in niches in the parapet of the emplacement. For this purpose, ammunition boxes frequently are buried in the parapet so their open ends are flush with the inside of the parapet; or types of shelters similar to those described in paragraph 51 may be used. Ammunition stored within the weapon emplacement should be arranged in the niches to prevent the base of a live round from being struck by ejected shell cases.

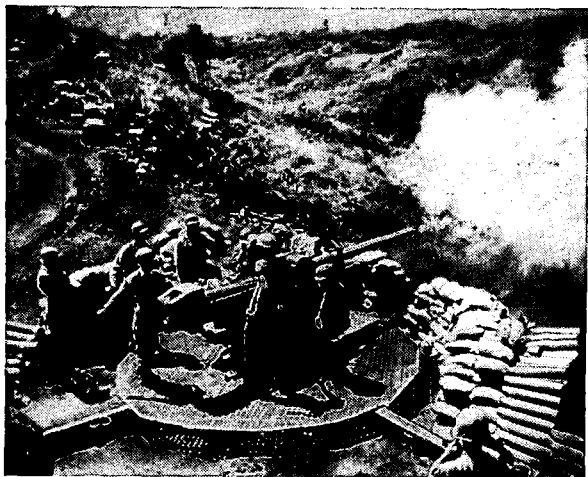
b. The remainder of the ammunition is stored in battery dumps. When time is limited, an open-pit type of ammunition shelter may be used (fig. 68); but if time permits, shelters with 3 feet or more of overhead cover should be provided. A trench or pit covered by logs, sandbags, and earth (fig. 66), or a cut-and-cover shelter similar to that shown in figure 70 may be used. A trench or sandbagged passageway with at least one right-angle turn to reduce blast effect must lead to the entrance of the shelter.

63. 90-mm ANTI-AIRCRAFT GUN M1 ON MOUNT M1A1. Unless it is possible to prepare the emplacement ahead of time, the emplacement for the gun on the mount M1A1 is built in two stages. First, the main pit, ramp, and outrigger trenches are excavated; the gun

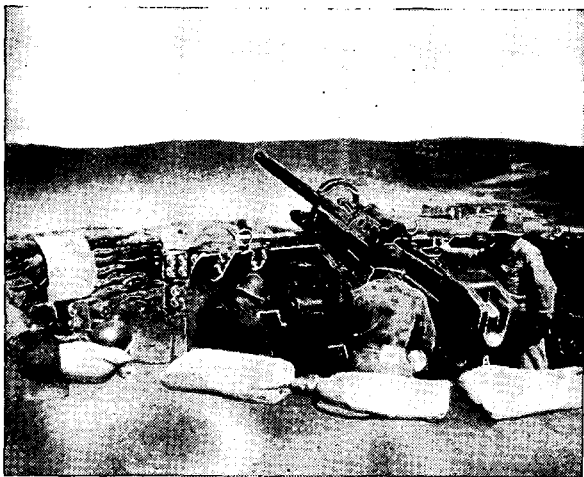
then is emplaced, leveled, and prepared for action, as shown in figure 79 ①. Second, parapets are built and, when necessary, revetted; ammunition niches are provided; outriggers covered; and the ramp closed off, as shown in figure 79 ②. When the bogies are removed from the carriage they should be covered with sandbags or provided with similar protection. In figure 79 ③ note that—

- (1) The outrigger trench is covered in a manner to permit ready withdrawal of the outriggers, yet prevent a break in the parapet. It is overlaid with brush or boards and covered with enough dirt to make a continuous parapet around the gun.
- (2) The ramp is closed off with sandbags or other readily removable material.
- (3) Four ammunition niches are provided. Each is formed by placing boxes of ammunition in the parapet with ends flush with the inside wall and then removing the exposed end of each box.
- (4) A short tunnel is built in the parapet for the power-transmission and data cables.

64. 90-mm ANTIAIRCRAFT GUN M2 ON MOUNT M2. This emplacement (fig. 80) is similar to the one described in paragraph 63 except that it is somewhat larger, has a ramp at both ends for the front and rear bogies, and has a greater inside depth.

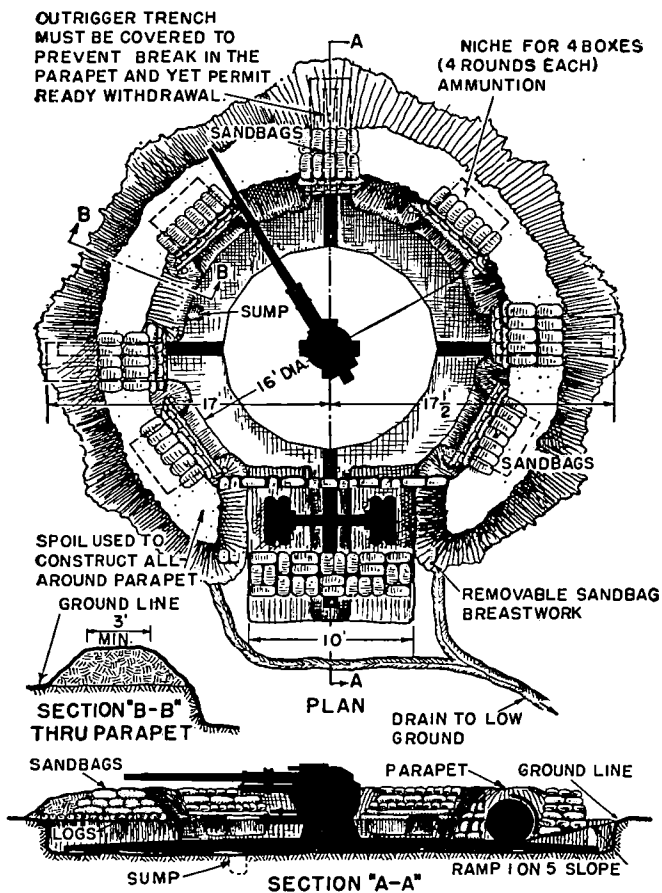


① First stage



② Second stage

Figure 79. Emplacement for 90-mm anti-aircraft gun M1 on mount M1A1—Continued.



③ Final emplacement

Figure 79. Emplacement for 90-mm antiaircraft gun M1 on mount M1A1—Continued.

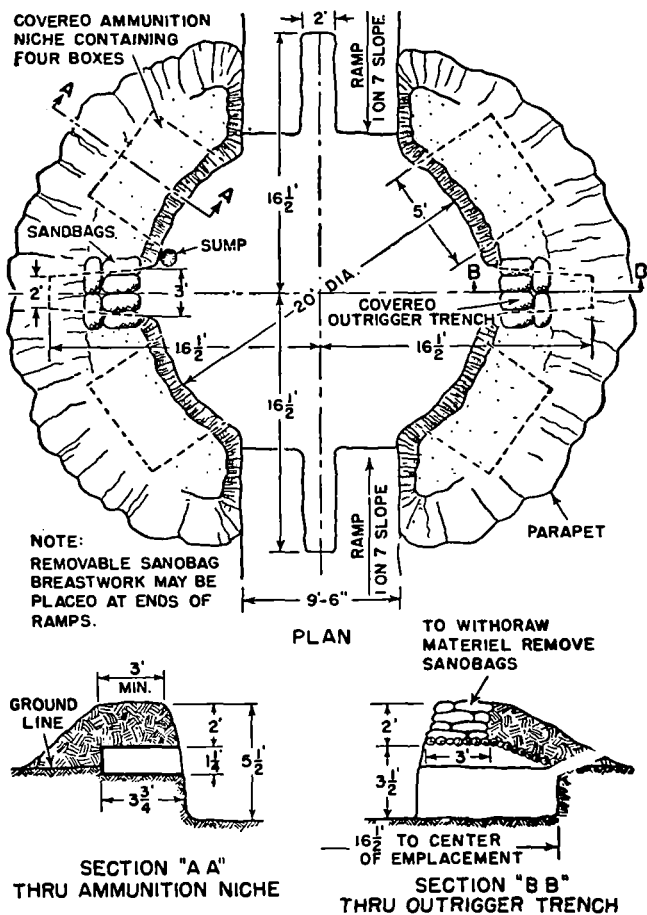


Figure 80. Emplacement for 90-mm anti-aircraft gun M2 on M2 mount.

65. 120-mm ANTI-AIRCRAFT GUN M1 ON MOUNT M1.

This emplacement (fig. 81) is similar to the one shown in figure 79 but is larger.

66. POWER PLANT M7 (fig. 82). An extension is connected to the exhaust to carry the fumes out of the emplacement. The transmission cable is buried, as indicated in paragraph 72.

67. TRACKER OF DIRECTOR M9 OR M10. a. The tracker emplacement (fig. 83) is a circular pit large

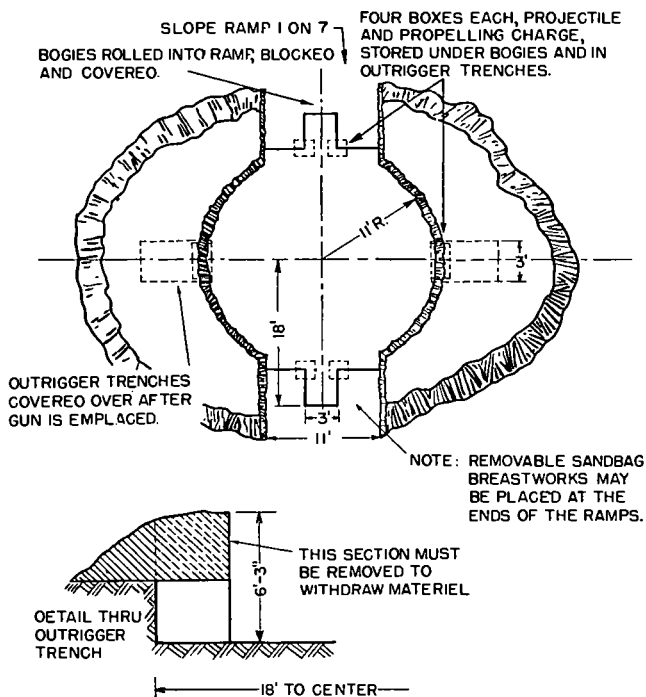


Figure 81. Emplacement for a 120-mm anti-aircraft gun M1 on M1 mount.

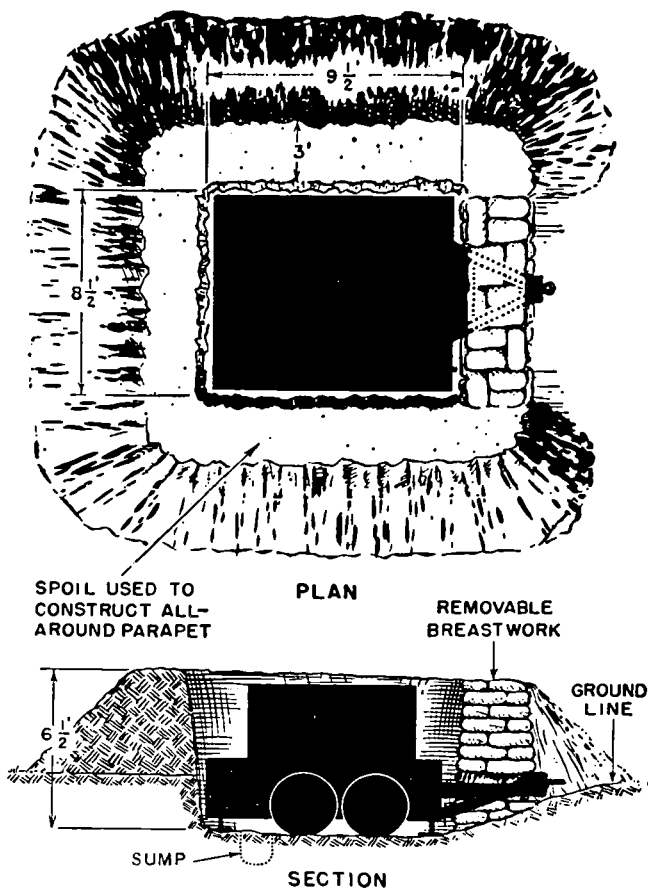


Figure 82. Emplacement for power plant M7.

enough to accommodate the tracker head with seats attached. It is deep enough to protect operating personnel while allowing full use of the tracker telescopes at low elevations.

b. An emplacement for the director trailer is shown in figure 84.

68. **DIRECTOR M7.** The emplacement for the director M7 is a circular pit about the same size as the pit for

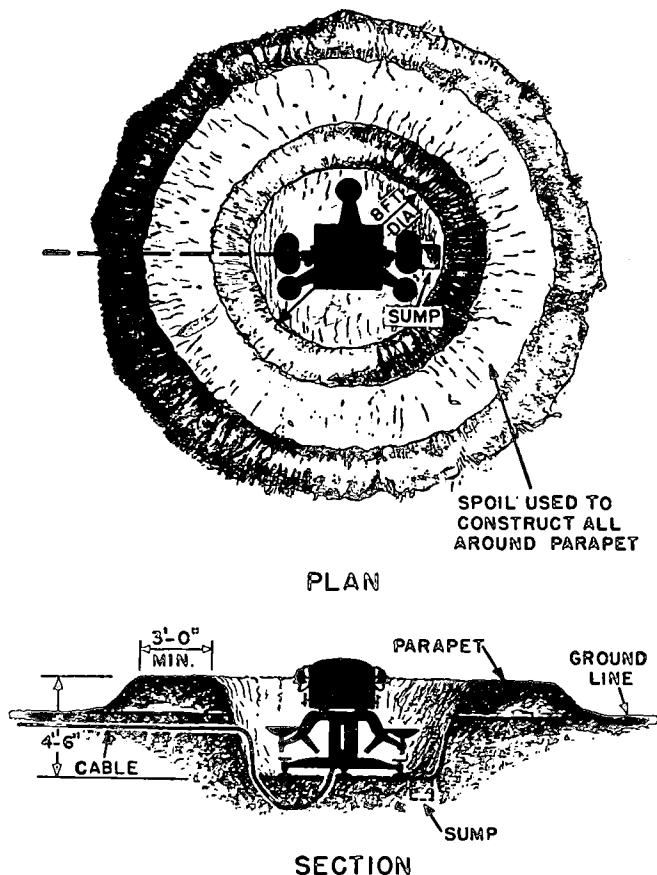
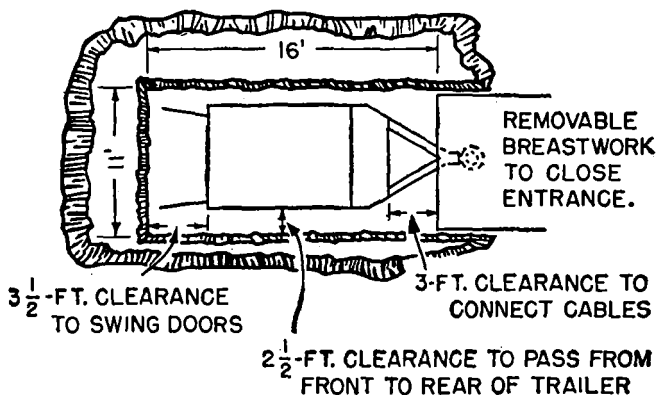
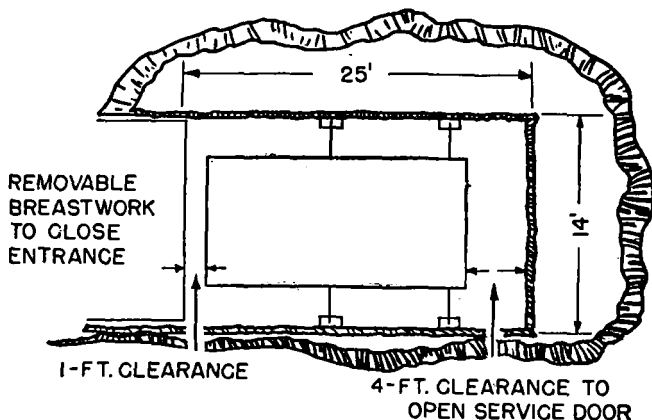


Figure 83. Emplacement for tracker of M9 or M10 director.



INSIDE HEIGHT TO BE 8 FT.

Figure 84. Emplacement for M9 or M10 director trailer.



4-FT. CLEARANCE EACH SIDE TO PERMIT
OPENING OF OPERATION DOORS.

INSIDE HEIGHT TO BE 10 FT. 4 IN.

Figure 85. Emplacement for SCR-584.

the tracker of the director M9 or M10 (fig. 83). It can be deeper since the telescopes are mounted higher.

69. SCR-584. The SCR-584 is emplaced in a rectangular pit, the dimensions of which allow a 4-foot clearance on the back and the two sides, and a 1-foot clearance on the front for necessary servicing. (See fig. 85.)

70. RADAR SCR-784. a. After the general location has been selected, a comparatively level site should be chosen for the trailer. The leveling jacks have a maximum range of 6° from side to side and 3° from front to back. Therefore, if an approximately level site cannot be found, an area of adequate size must be graded.

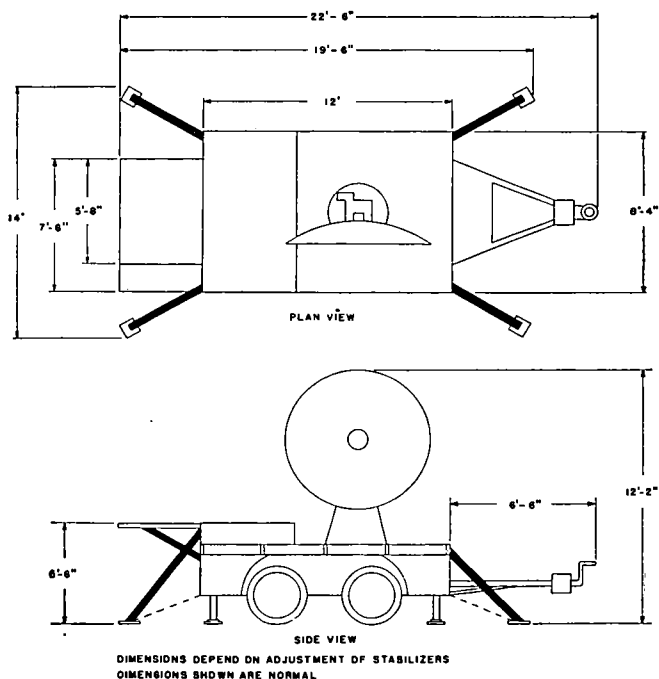
b. Over-all dimensions of the SCR-784 which must be considered in planning an emplacement are shown in figure 86 ①. Note that two dimensions vary according to the length at which the stabilizers are set.

c. An example of an emplacement is shown in figure 86 ②. In this example the stabilizers are not used and the emplacement is made as small as practicable. The height of the sandbags should not be greater than the highest level of the trailer top. After the equipment has been emplaced, the opening in the ramp must be sandbagged. An emplacement of this type can be camouflaged easily; however, caution must be exercised in any attempt to camouflage the antenna as some materials which may be placed in front of the antenna will diminish power output and tracking accuracy. In using an emplacement similar to the example in figure 86②, the following precautions must be observed:

- (1) The antennas, echo box, tools, and other equipment which may be needed in operation

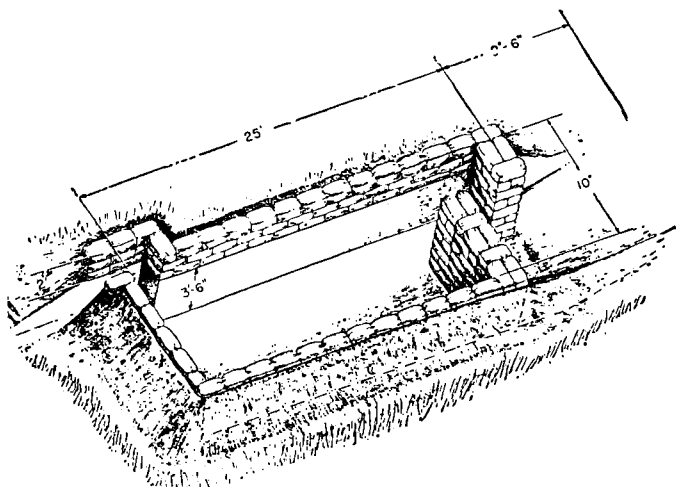
must be removed from the four storage compartments at the corners of the trailer before the trailer is moved into the emplacement.

- (2) The IFF equipment must be put into operating position before the rear wall of the emplacement is completed.
- (3) Provision must be made to enable personnel to operate the switches and install cables at the switch and data panel on the front of the trailer.



① Dimension of emplacement.

Figure 86. Emplacement for SCR-784.



② Birds-eye view of emplacement.

Figure 86. Emplacement for SCR-784—Continued.

d. In case camouflage or other protective material is placed over the trailer top, provision must be made to allow access to the front and rear hatches. Care must be taken that sand does not get into the interior of the trailer and that too much weight is not placed on the trailer top.

e. Circulation of air for cooling and ventilating must not be impaired.

71. BC SCOPE. The emplacement for the BC scope is similar to that for the searchlight control station (see par. 78). It is a circular pit large enough to accommodate the instrument and manning operators, and of a depth that does not obstruct the view at low angular heights.

72. CABLES. For protection in static positions, power-transmission and data-computer cables are buried in a shallow trench. If freezing is likely, the cable is wrapped in several thicknesses of burlap or cloth to prevent damage when it is dug up later. A trench of the shape shown in figure 87 provides good drainage and protection for the cable. The trench may be covered with discarded ammunition boxes or canvas. In mobile situations, cables normally are not buried.

73. 40-mm GUN AND DIRECTOR. The emplacement for gun and director of a 40-mm antiaircraft artillery fire unit is laid out as indicated in figure 88. With the director pit so located, the director is from 13 to 15 feet from the pintle center of the gun. A short tunnel for the cable connects the director and gun pits. The inside height of the emplacement is low enough to permit

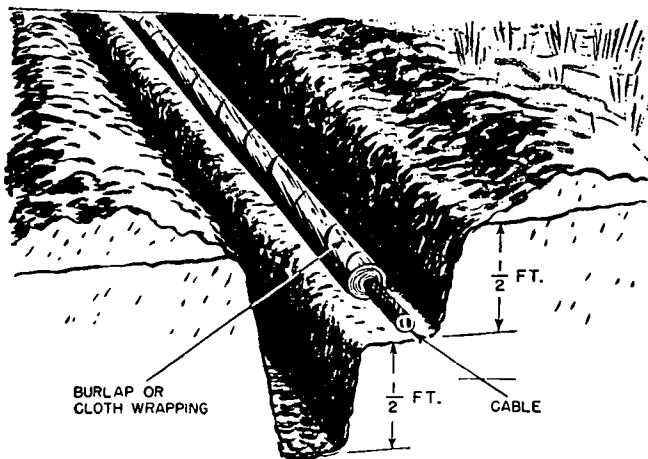


Figure 87. Trench for burying power-transmission cable.

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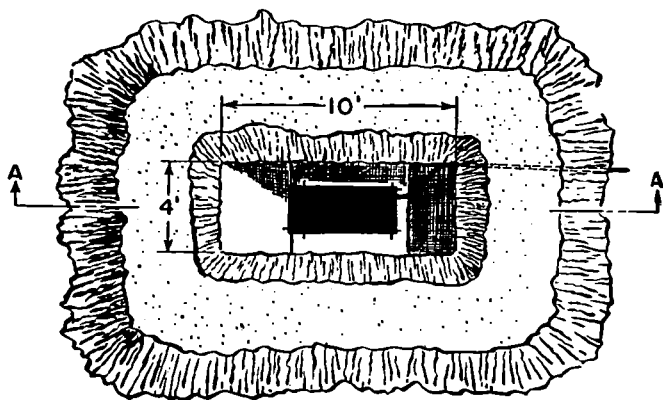
tection. Ammunition niches are constructed in the sides of the emplacement. In stabilized situations, the wheels of the 40-mm gun are removed to a place of greater safety. If the fire unit expects to move on short notice, the wheels remain on the carriage. Sandbagging the wheels is advisable, provided it does not interfere with the operation of the weapon.



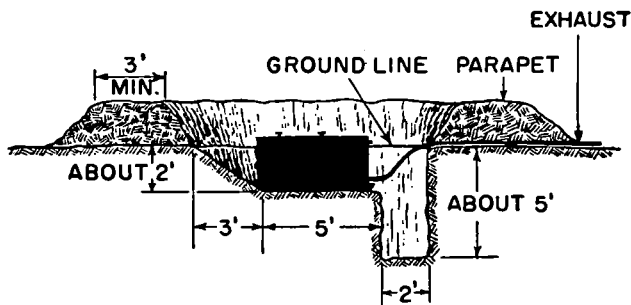
② Perspective view

Figure 88. Emplacement for 40-mm anti-aircraft gun and director—Continued.

74. POWER PLANT M5 OR M6. The emplacement for an M5 or M6 power plant (fig. 89) is a rectangular pit with a trench for the operator at one end. At static positions, cables usually are buried (par. 72). An extension is provided for the exhaust to carry fumes out of the pit.



PLAN



SECTION ON LINE "A - A"

Figure 89. Emplacement for power plant M5 and M6.

75. MULTIPLE-GUN MOTOR CARRIAGE. Emplacements for multiple-gun motor carriages, which are mounted on standard half-tracks, and for M19 full track gun carriage, consist of pits to fit the vehicles. Each pit must be of a depth to allow the weapons to fire horizontally, and its bottom must be nearly level. Access

to the pit is by a ramp. The vehicle is backed into the pit to permit more rapid exit if the need arises. (See fig. 90.)

76. CALIBER .50 ANTI-AIRCRAFT MACHINE-GUNS.

a. Multiple, caliber .50 machine-gun carriage M55. The emplacement for this weapon is a circular pit 11 feet in diameter and 2½ feet deep. A recess for the drawbar and niches for extra ammunition chests are built into the parapet. Figure 91 shows a built-up emplacement for this weapon of sandbags since the frozen ground was too hard for digging. Figure 92 shows a dug-in emplacement for this weapon in medium ground.

b. Mount, machine gun, anti-aircraft, caliber .50, M63. The emplacement for the machine gun, anti-aircraft, caliber .50 on mount M63 is a donut-shaped pit about



Figure 90. Emplacement for a multiple gun motor carriage.



Figure 91. Built-up emplacement for multiple caliber .50 anti-aircraft machine gun carriage M55.

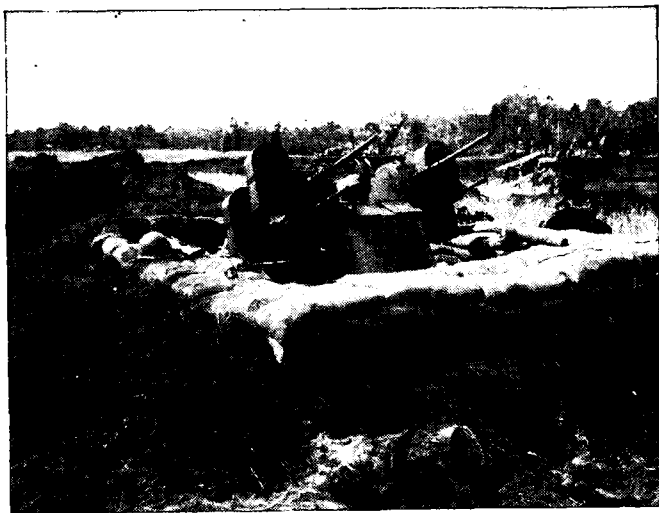
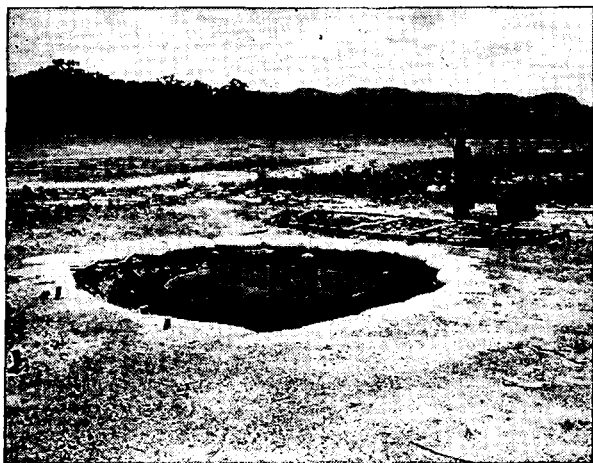


Figure 92. Dug-in emplacement for multiple, caliber .50 machine-gun carriage M55.



① A dug-in emplacement in loose soil revetted with sandbags



② A dug-in emplacement in firm soil

Figure 93. Three types of emplacements for caliber .50 anti-aircraft machine gun on mount M63.



③ A built-up emplacement in rocky soil; rocks, sandbags and soil covered with turf and sides of emplacement revetted with cut lumber

Figure 93—Continued.

9 feet in diameter (fig. 93). A circular firing table, about 3 feet in diameter is formed by digging a waist-high trench about $2\frac{1}{2}$ to 3 feet in width. The gunner and his assistant stand in the trench and fire the weapon in any direction by moving around the trench. Three types of emplacements for this weapon are shown in figure 93.

Section VIII. SEARCHLIGHT EMPLACEMENTS

77. SEARCHLIGHT. The emplacement for the light (fig. 94) is a circular pit with a ramp at one end which is closed with a sandbag parapet. Protection is limited because of the necessity for illuminating at low heights.

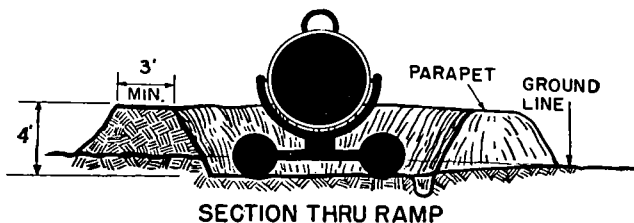
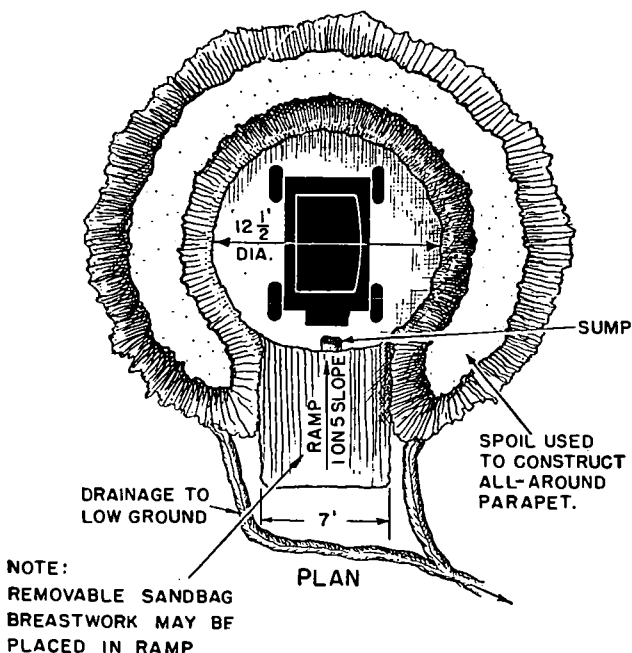
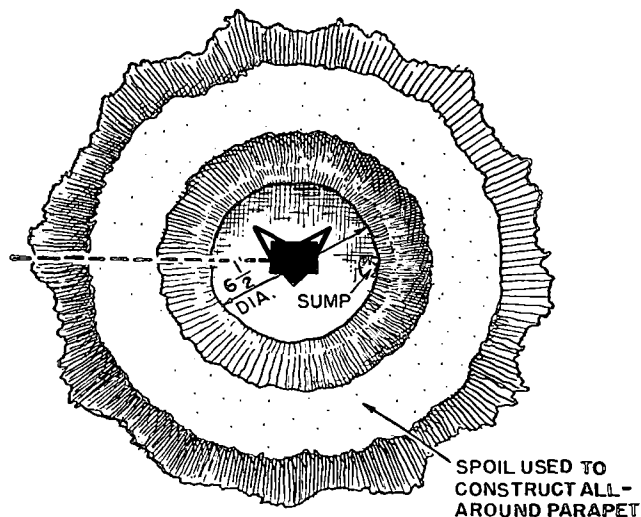
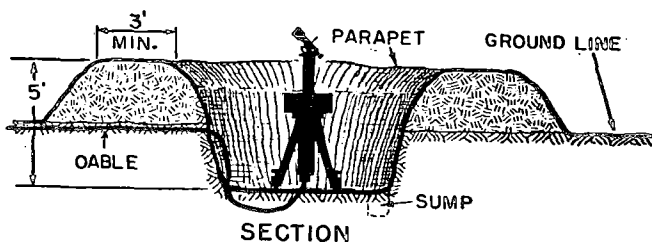


Figure 94. Searchlight emplacement.

78. CONTROL STATION. The emplacement for the control station (fig. 95) is a circular pit which provides protection for all parts except the binoculars.



PLAN



SECTION

Figure 95. Emplacement for searchlight control station.

79. POWER PLANT. The emplacement for the searchlight power plant (fig. 96) is a rectangular pit which provides protection for the power plant and operator. An extension is placed on the exhaust pipe to carry the fumes out of the pit. Searchlight cables should be buried or trenched in stabilized situations.

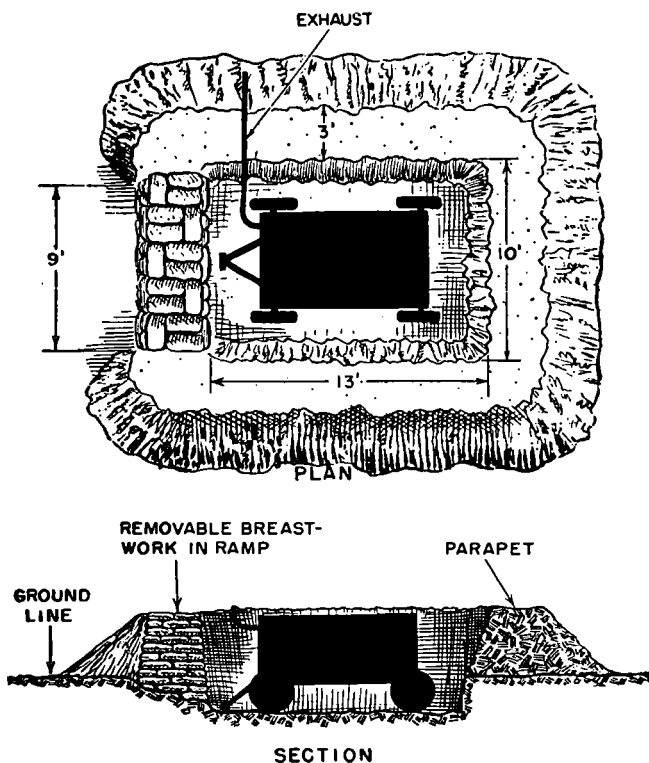


Figure 96. Emplacement for searchlight power plant.

80. RADAR AN/TPL-1 EMPLACEMENT. Operation of the AN/TPL-1 may be accomplished from a dug-in position (fig. 97), which gives maximum protection to the operating personnel. The openings in the ramp must be closed by sandbagging after the equipment has been emplaced. Recesses can be added at each end to give

protection to the bogies. Approximately 12 man-hours are required to dig the emplacement in medium soil and place the sandbags.

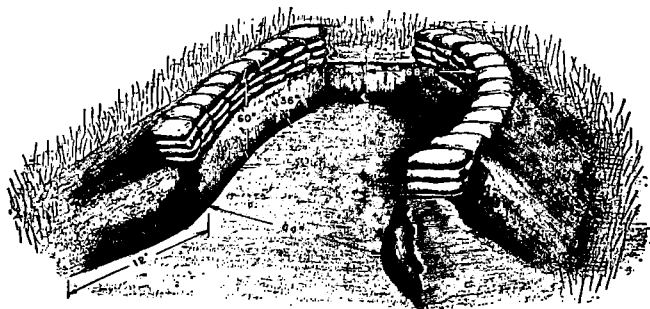


Figure 97. Emplacement for AN/TFL-1.

CHAPTER 3

SHELTERS

Section I. INTRODUCTION

81. GENERAL REQUIREMENTS. Shelters (both hasty and deliberate) are constructed primarily to protect troops and equipment from enemy action and the weather. They are built when no other form of existing cover is available. Shelters are not fighting emplacements, but often are included in or near fighting positions. Permanent shelters (concrete, steel) are described in TM 5-310.

a. Because combat troops preparing defensive positions have some shelter in their fighting holes to protect them from the weather and most forms of enemy action, it is not necessary nor desirable for them to build additional shelters. The fighting hole, which is always constantly improved upon in defensive works, not only affords shelter, but enables the occupants to return immediate effective fire to assaulting enemy infantry, following a hostile artillery or aerial bombardment. Shelters ordinarily are prepared by troops in support of front-line units, by troops making a temporary halt in inclement weather when moving up to positions, and by soldiers in bivouacs, assembly, and rest areas.

b. Wherever possible shelters should be sited on reverse slopes, in woods, or in some form of natural defilade such as ravines, valleys, and other hollows or

depressions in the terrain, but not in the path of natural drainage lines. All shelters must be camouflaged or concealed.

82. WINTER SHELTERS. a. Shelter sites.

- (1) *Wooded country.* In winter, shelter sites near wooded areas are most desirable because these areas are warmer than open fields, conceal the glow of fires, and provide fuel for cooking and heating. Trees with branches extending down to the snow afford good shelter possibilities for smaller units which are heavily snowed in.
- (2) *Barren terrain.* Low ground, depressions, and valleys have lower temperatures than the surrounding higher ground but afford better concealment and more shelter than high ground. Areas free of snow are exposed to the wind and are not suitable for bivouacs. Snowdrifts around hollows and accumulations on the lee side of elevations may be used in the construction of snow caves.

b. General construction considerations.

- (1) Work on the bivouac must begin immediately after the halt so the men may stay warm. Extra time spent on construction shortens the time available for rest but insures greater relaxation and warmth later. Beds of foliage, moss, straw, boards, skis, furs, and shelter halves may be used as protection against dampness and low ground temperatures. Clothing and equipment must be cleaned of snow before being brought into the bivouac.

The entrance of the shelter must be located on the side that is least exposed to the wind. It should, if possible, be close to the ground and have an upward incline. The shelter itself should be as low as possible, while bedding facilities should be as high as possible. The sources of heat must be placed low in fire holes and cooking pits. Special protective walls and plastering with earth and snow minimize the effect of wind.

- (2) Snow is windproof and retains warmth (three times the warmth retained by wood). To keep the occupant's body heat from melting the snow, it is necessary only to place a layer of some insulating material such as a shelter half, blanket, or overcoat between the body and the snow.
- (3) When the ground is frozen too hard for digging trenches, snow walls may be used for cover. The thickness necessary for various types of snow walls to provide protection from rifle bullets and shell splinters from small-caliber guns is as follows:

Newly fallen snow.....At least 13 feet.

Firmly frozen snow...At least 8 to 10 feet.

Packed snow.....At least 6½ feet.

Ice.....At least 1 foot.

83. MOUNTAIN SHELTERS. Shelter for troops in high altitudes is particularly important because of the frequent, rapid, and extreme changes of weather at all seasons. Mountain shelters may take the form of hastily devised types for a halt or short bivouac (see sec. II,

this ch.). They may be constructed on the spot or prepared by advance parties at appointed bivouac areas. In snow-covered regions, snow trenches or caves may be dug and are superior to tents because they are warmer and do not require materials which have to be transported by men or pack animals. They also furnish better protection from enemy observation and from small-arms fire or shell fragments. When there is no snow, log huts may be built and revetted with stones. This type of shelter provides some security from enemy fire or shrapnel and can be used as a fortification in case of a raid by an enemy patrol. (fig. 98).



① Rocks cemented together

Figure 98. Two types of mountain shelters of rocks.



② Loose rocks over a wood frame

Figure 98. Two types of mountain shelters of rocks—Continued.

84. CLASSIFICATION. Hasty and deliberate shelters are of three general types. Some examples of each type are shown in figure 99.

a. Surface shelters. This type is built above the surface of the ground, usually with local, expedient materials. Being above ground, this type shelter is the most conspicuous and the most vulnerable to enemy fire. Hasty shelters usually are of this type.

b. Cut-and-cover shelters. These shelters are dug into the ground and back-filled on top with as thick a layer as possible of rocks, logs, sod, and excavated soil. These and the cave type afford maximum protection from weather and enemy action.

c. **Cave shelters.** Caves are dug or drilled laterally into hillsides, ridges, and mountains. They usually are the best concealed of all because the topsoil is undisturbed and the cave entrance is easily camouflaged.



① Hasty surface shelter of evergreen boughs

Figure 99. Examples of various types of shelters.



② Log cabin type surface shelter

Figure 99. Examples of various types of shelters—Continued.



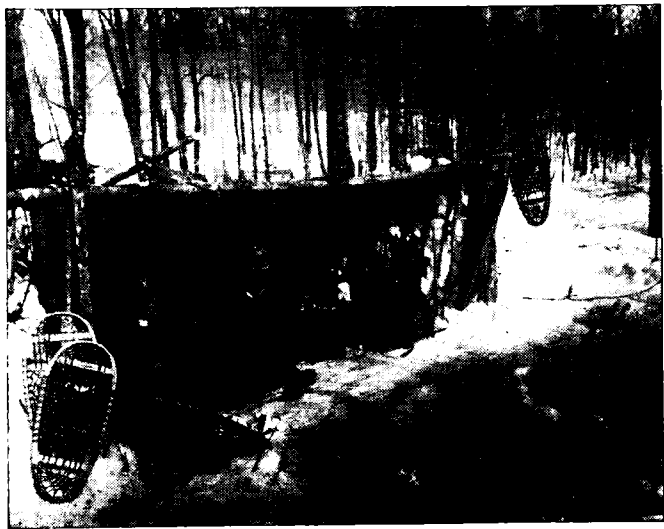
③ Cut-and-cover personnel shelter revetted with empty ammunition boxes

Figure 99. Examples of various types of shelters—Continued.



④ Cave shelter

Figure 99. Examples of various types of shelters—Continued.



⑤ Lean-to type shelter of saplings, tarpaulin, and snow
Figure 99. Examples of various types of shelters—Continued.

Section II. HASTY SHELTERS

85. GENERAL. a. In the absence of existing shelter in uninhabited areas, combat troops construct improvised hasty shelters from available natural materials. Protection from extreme weather conditions, especially in winter, is thus provided during short bivouacs.

b. Hasty shelters are constructed with a minimum expenditure of time and labor and ordinarily are built above ground or dug in deep snow. Those completely above ground offer protection against the weather only. They are designed to shelter from one to three men, and supplement or replace shelter tents which afford little or no room for movement, sitting, or cooking.

c. Hasty shelters usually are constructed in winter when the ground is frozen, in mountainous country where the ground is too hard for deep excavation, in deep snow, in swampy and marshy ground, and when inclement weather conditions exist.

86. WIGWAM SHELTER. a. General. In wooded, snow-covered terrain when the ground is too hard to dig and immediate shelter is desired for a short bivouac, the wigwam shelter (figs. 100 and 101) is constructed easily and quickly. It will house three men, and provides space for cooking on small Coleman stoves.

b. Construction. Cut about 25 saplings, 2 to 3 inches in diameter and 10 feet long. Evergreen saplings are the best, but other types can be used. Leaving the limbs on the saplings, lean them up against a small tree so the butt ends are about 7 feet up the trunk. Tie the butts together around the tree with a tent rope, wire, or

other means. Space the other ends of the cut saplings about 1 foot apart, around and about 6 feet from the base of the tree. Then trim off all the branches inside the wigwam and bend down those on the outside so they lay flat against the saplings (fig. 100). The branches trimmed off from the inside may be used to



Figure 100. Wigwam built around a tree.

fill in any spaces left. Wrap shelter halves around the outside of the wigwam to make it more windproof. Pack snow scraped from inside the wigwam around the outside base of the shelter and on the wigwam itself.

c. Figure 101 shows a similar shelter with more room which may be made without using a tree as a base or support.

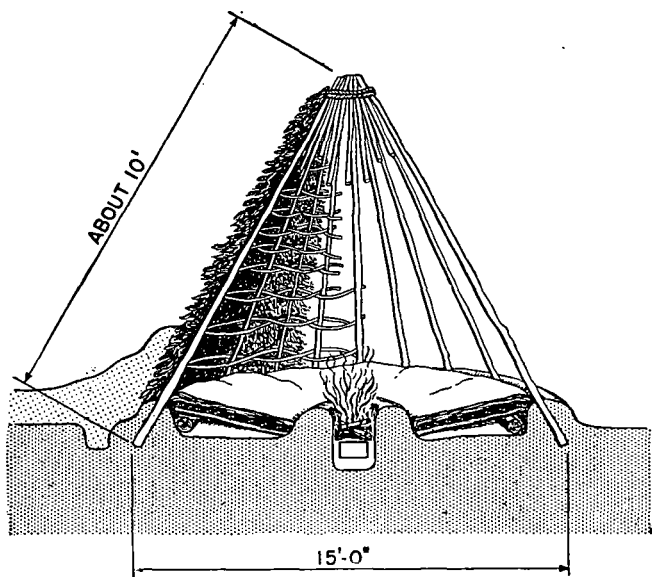


Figure 101. Wigwam shelter.

87. LEAN-TO SHELTER. This shelter is made of the same materials as the wigwam (natural saplings woven together, and brush). The saplings are placed against a rock wall, a steep hillside, a deadfall, or some other existing vertical surface, on the leeward side. (See fig. 102.) The ends may be closed with shelter halves or

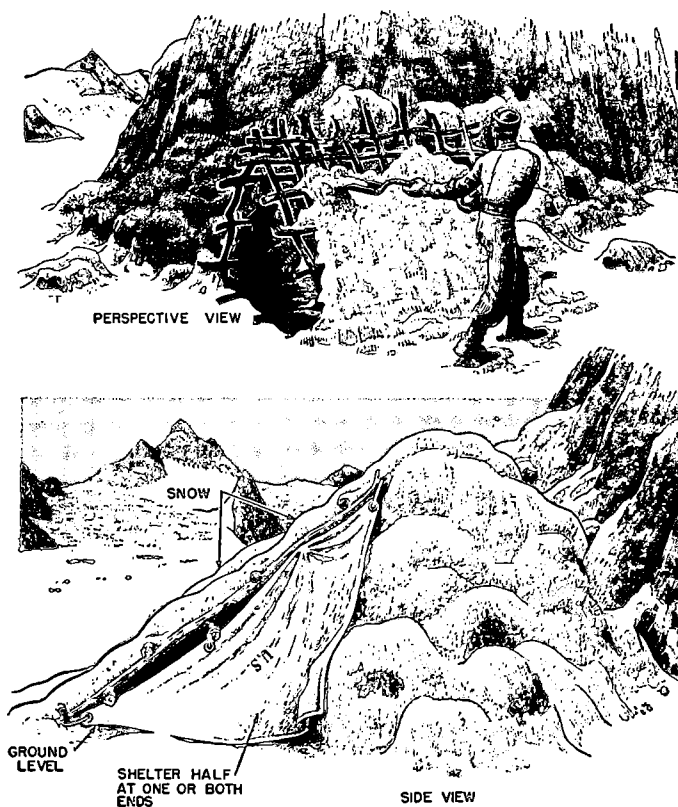


Figure 102. Lean-to shelter constructed against a rock.

evergreen branches. Figure 103 shows other ways of utilizing a lean-to type shelter as protection for truck repairmen and animals.

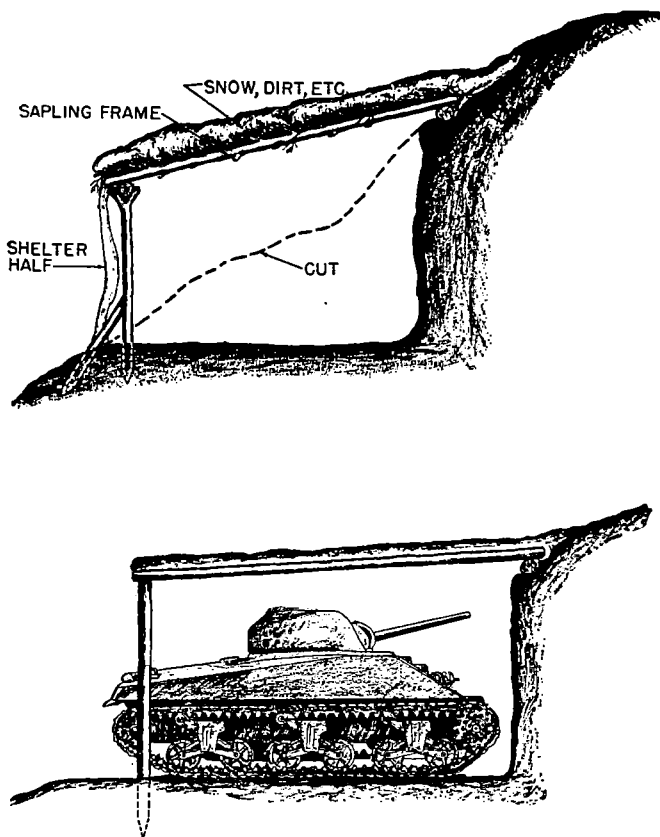


Figure 103. Uses of a lean-to shelter.

88. PRONE SHELTER. Prone shelters (fig. 104) are used primarily in rear areas to protect men from bomb and shell fragments. They also protect against small-arms fire, but cannot be used when soldiers have to return fire. They are not as effective as fox holes and provide no protection against the crushing action of tanks. However, they can be dug quickly and give the soldier a protected place in which to rest. Prone shelters usually are authorized in rear areas when ground attack is unlikely or when there is not enough time to dig fox holes. They seldom are used in forward areas except during halts of 6 hours or less, as in assembly areas before going into combat.

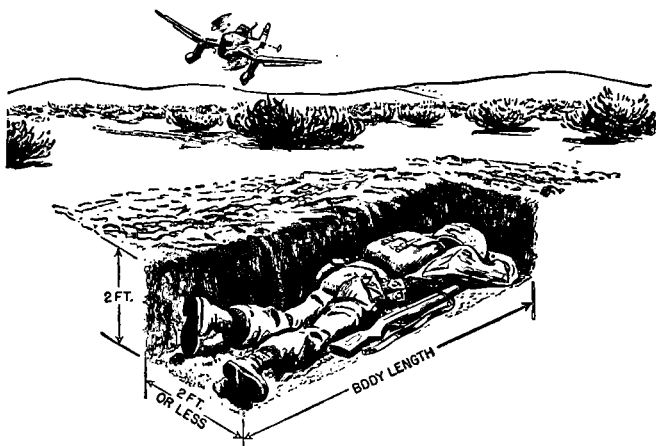


Figure 104. Prone shelter.

89. TWO-MAN MOUNTAIN SHELTER (fig. 105). This shelter has proved acceptable for use in mountainous terrain, particularly in winter or in inclement weather when there is almost daily precipitation and under con-

ditions where the usual fox hole is not feasible because of the rocky soil. These shelters are basically holes 7 feet long, 3 feet wide, and 3 feet deep. The holes are covered with 2- or 3-inch diameter logs; then with evergreen branches, a shelter half, and local topsoil (leaves, snow, twigs, and the like). The floor may be covered with evergreen twigs, a shelter half, or other expedient material. Entrances may be provided at both ends if desired. A fire pit may be dug at one end for a



Figure 105. Two-man mountain shelter.

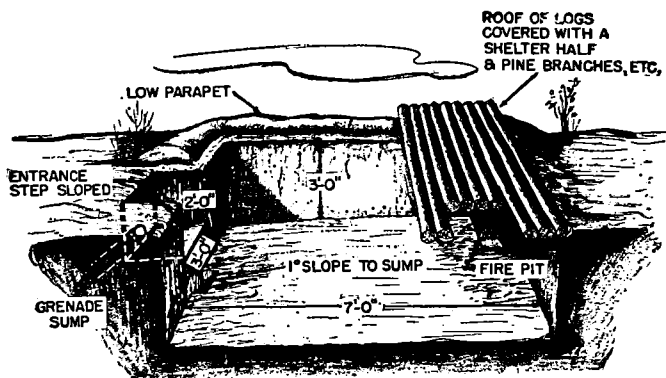


Figure 105. Two-man mountain shelter—Continued.

small fire or a small Coleman stove. A low earth parapet is built around the emplacement to provide more height for the occupants. This shelter is very similar to an enlarged roofed, prone shelter.

90. SNOW HOLE (fig. 106) The snow hole is a simple, one-man emergency shelter for protection against a snow storm in open, snow-covered terrain. It can be made rapidly, even without tools. To construct a snow hole, a soldier lies in snow at least 3 feet deep. He pushes with his feet, digs with his hands, and repeatedly turns over, forming a hole the length of his body and at least as wide as his shoulders. After reaching a depth of at least 3 feet, the soldier digs in sideways below the surface, filling in the original ditch with the snow he is excavating until only a small opening remains. This opening may be entirely closed, depending upon the enemy situation and the temperature; the smaller the hole the warmer the shelter.

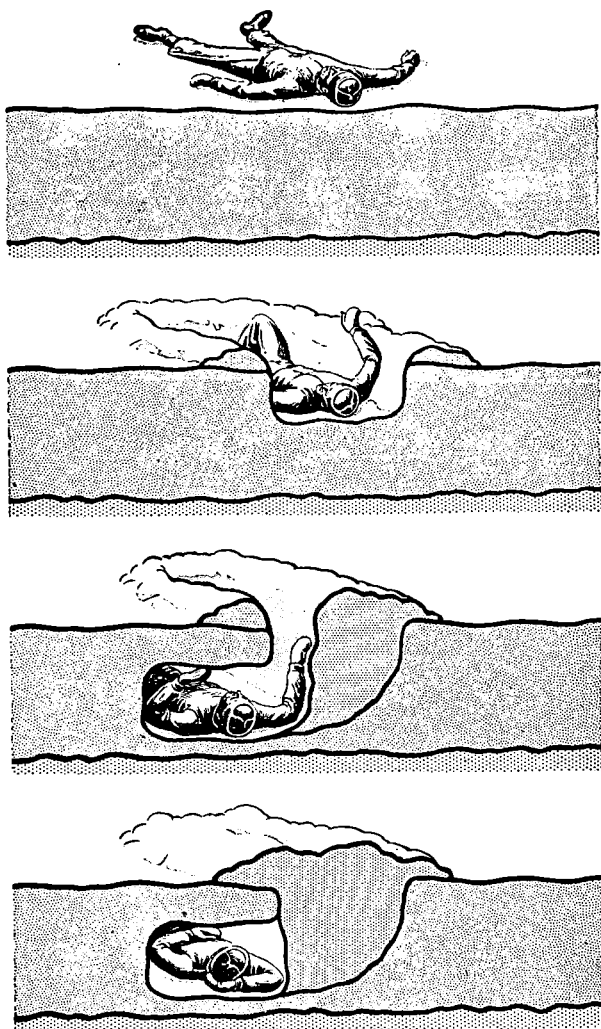


Figure 106. Making a snow hole without tools.

91. SNOW CAVE. Snow caves (fig. 107) are made by burrowing into a snow drift and fashioning a room of desirable size. This type of shelter affords excellent protection from freezing weather and a maximum amount of concealment. For best protection against the penetration of cold air, the entrance is made to slope upward. Snow caves may be built for several men if the consistency of the snow is such that it will not cave in. To expedite construction, the work is started from two entrances. One entrance is sealed after completion of the cave.

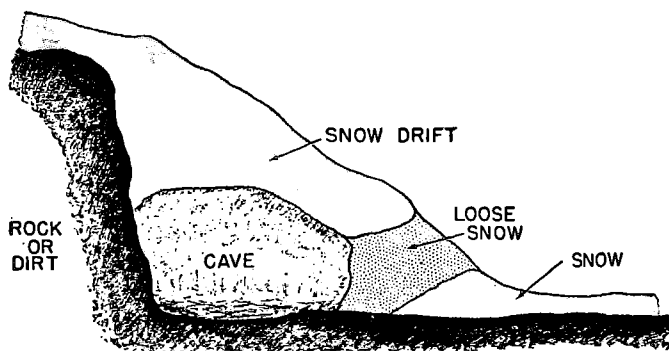


Figure 107. Snow-cave shelter.

92. SNOW PIT. The snow pit (fig. 108) is dug vertically into the snow with intrenching tools. It is larger than the snow hole, providing shelter for two or three men. Skis, ski poles, sticks, branches, shelter halves, and

snow are used as roofing. The inside depth of the pit depends upon the depth of the snow, but should be deep enough for kneeling, sitting, and reclining positions. It is advisable to slope the roof down toward one end. If the snow is not deep enough, the sides of the pit are made higher by adding snow walls.

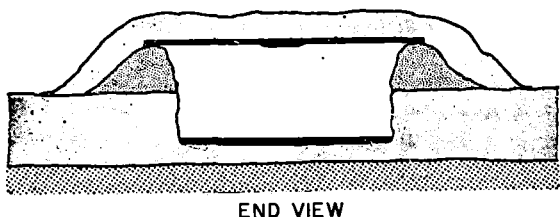
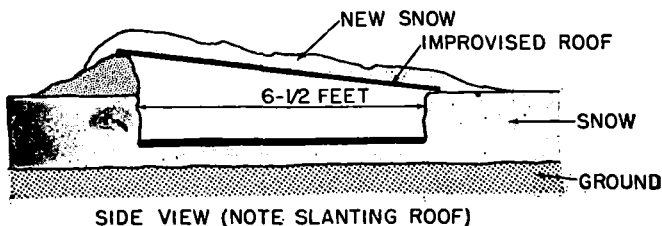


Figure 108. Snow pit in shallow snow. Note slanting roof in side view.

93. JUNGLE RAIN SHELTER. In tropical climes or jungle areas where there are daily showers, a satisfactory bed and rain shelter (fig. 109) may be constructed in a short time from natural materials. The bed itself is made

first at a height of about 3 feet above the ground. Four forked stakes, about 4 feet long and 2 inches in diameter, are driven into the ground. Next, a timber framework lashed together with vines, rope, or wire is placed upon the stakes. Then stout but pliable reeds, such as bamboo shoots, are laid over the framework, then these are covered with several layers of large, fine ferns. To construct the roof, four longer stakes are driven into the ground alongside the bed stakes (or existing saplings may be used as stakes). The roof must slant either to front or rear to allow rain to run off. Leaves used for roofing should be laid with the butt ends toward the high end of the room.

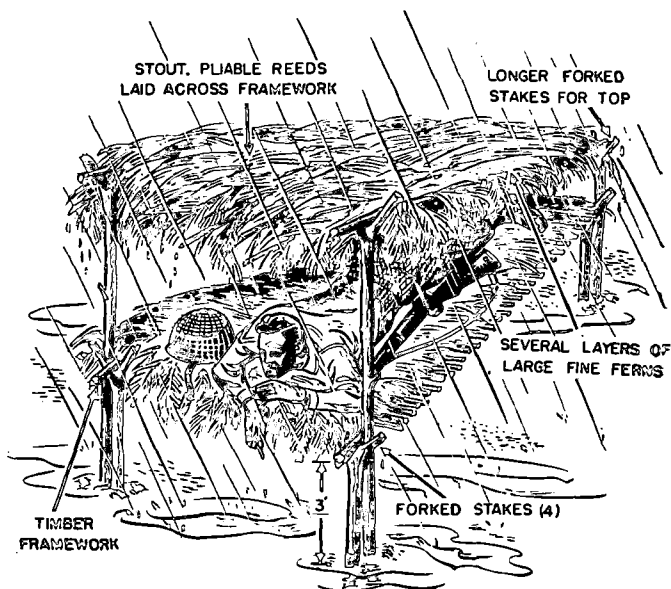


Figure 109. Jungle rain shelter.

Section III. DELIBERATE SHELTERS

94. GENERAL. a. The most effective shelters are the deliberate, underground, cut-and-cover or cave shelters which are constructed at troop-concentration points in rear areas. Wherever ground conditions permit excavation, shelters should be underground and provided with as deep overhead cover as possible. The shelters should be dispersed and, if designed for personnel occupancy, should have a maximum capacity of two squads (20 to 25 men). Supply shelters may be of any size, depending upon the location and the time and materials available. The larger the shelter the greater the necessity for easy entrance and exit. The largest shelters must have at least two exits spaced widely apart and well camouflaged.

b. The necessity for shelter becomes greater as stabilization develops and details of the position become known to the enemy. The farther away from the front lines the larger, deeper, and more substantial a shelter may be constructed because of more freedom of movement, easier access to materials, and more time to spend on the job.

95. CONSTRUCTION REQUIREMENTS. a. **Observation.** If practicable, shelters should be provided with some means of observation, such as loopholes in a surface shelter or a camouflaged periscope in an underground shelter.

b. **Drainage.**

(1) With cut-and-cover and cave shelters particularly, drainage is a very important and

often complex problem. Before and during excavation such subsurface conditions as the extent and character of underlying rock, position and thickness of impervious and water-bearing strata, and the amount of water to be controlled will be encountered and must be dealt with.

- (2) After the shelter is dug, drainage problems include keeping surface and rain water away from the entrance, preventing water from seeping into the interior, and removal of water that has collected inside the shelter. The floors of shelters must have a slope of at least 1 percent (1 foot to 100 feet). Slopes should fall toward the entrance which must be sloped more steeply toward a ditch or sump outside the shelter. (See fig. 110.)

c. Seepage. Protection against water seeping into shelters is important. In a surface or cut-and-cover shelter, this is accomplished by placing tarpaper between the sheeting and the cover. In cave shelters, a strip of corrugated iron may be placed on the cap of the frame

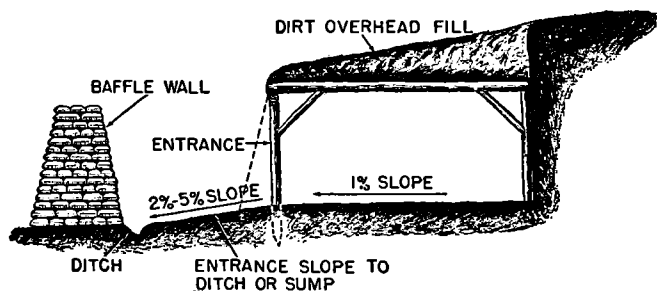


Figure 110. Floor and entrance slopes for drainage in underground shelters.

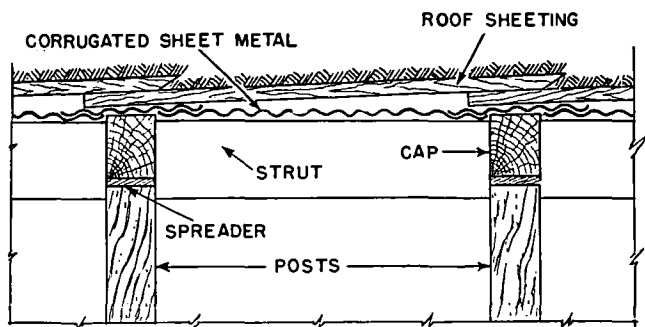


Figure 111. Waterproofing for a shelter roof.

(fig. 111). Sheetting then is driven over the iron. Space between caps is filled with an additional piece of corrugated iron supported by struts. Seepage thus is carried to the sides of the chamber where it collects in a ditch leading to a sump.

d. Ventilation. Ventilation is a particularly important factor in cave shelters. It includes the following problems:

- (1) Providing adequate circulation of fresh air in the incline, shafts, galleries, and chamber.
- (2) Gasproofing, or exclusion of gas from all parts of the shelter.
- (3) Providing pure air by means of air purifiers (collective protectors) when the entrances and ventilation shafts are closed during a prolonged gas attack.

e. Circulation of fresh air.

- (1) In surface and cut-and-cover shelters, enough fresh air usually is obtained by keeping entrances open. In cave shelters, ventilating shafts usually are necessary in addition to en-

trances. They are small, vertical shafts which may be bored from within after the completion of the shelter. A stovepipe through a shaft assists circulation of the air.

- (2) A gallery should not be driven more than 60 feet without artificial ventilation. A gallery with a single opening is ventilated by forcing fresh air to the working and through a duct of wood, metal, or canvas. A pressure blower worked by hand or power is an essential item of mining equipment. For small excavation, a portable forge may act as an expedient ventilating device. Drill-holes through the roofs of galleries promote ventilation. In a system of galleries having two or more outlets, air may be forced out from one outlet and drawn in through another. Screens or doors may be arranged to guide the distribution of fresh air. Vacuum operation is never as satisfactory as a pressure system.

f. Unventilated shelters. Shelters not provided with collective protectors should be used only by personnel who are to remain inactive during occupancy. Since an inactive man requires about 1 cubic foot of air per minute, the capacity of unventilated shelters is limited. Initial air-space requirements for shelters for not over 12 men are 150 cubic feet per man.

g. Gasproofing.

- (1) *General.* All deliberate shelters must be gas-tight; when not in use, shelters are sealed to exclude gas. Protected shelters are particularly subject to gas concentrations because of their

low level. Protection is provided by curtains on entrances. During extended gas attacks, men must be able to work and rest inside the shelter with gas masks removed. This is of greatest importance in shelters housing wounded personnel and in shelters used for telephone central and signal stations, observation posts, headquarters, and other activities where the wearing of gas masks would considerably reduce the efficiency of the occupants. See T M3-350 for details on gasproof shelters.

- (2) *Entrances.* The standard M1 gasproof curtain is designed to keep out gas. If it is not available, improvised curtains made of blankets are hung on light, sloping frames built to fit individual entrances. Frames should be nailed securely to the sides and top of entrance timbers. For cave shelters, it sometimes is necessary to place gas curtains on the steps but, whenever possible, they should be placed in horizontal entrances or horizontal approaches to inclines.
- (3) *Other openings.* Windows are covered with single curtains. All crevices should be caulked with clay, old cloths, or sandbags. Plugs, to be inserted during gas attacks, should be provided for periscope drainage and ventilating openings. Flooring or steps in front of gas curtains should be kept clear of mud and refuse. Curtains should be kept moist with water or gasproofing solutions. Fresh chloride of lime should be kept on hand and, when the area

is gassed, should be placed between gas curtains at the entrance so that personnel entering the dugout may neutralize mustard and other persistent gases on hands and feet.

(4) *Air locks.*

(a) Air locks are intermediate chambers between the outside and inside of shelters. They allow passage into the shelters, while excluding gas. Figure 112 shows a standard air lock suitable for most types of surface and cut-and-cover shelters; table IV is the bill of materials for its construction. Where desirable, construction may be modified to provide greater headroom. Figure 113 shows an air lock used in first-aid shelters. It is designed to allow the passage of litters and is adaptable to the shelters described in this chapter by increasing their height and width. Table V is the bill of materials for its construction.

(b) Certain doors at each end of the air lock usually are constructed with standard M1 gasproof curtains. When an air lock's outer doorframe projects from the entrance, the curtain must be about 4 inches wider and 4 inches longer than the doorframe. If the air lock is built back into the entrance, the curtain must be the same width as the doorframe. When not in use, the curtain is rolled up and placed on top of the air lock or in a box-shelf above the top of the doorframe. (For details on the M1 gasproof curtain, see TM 3-350.)

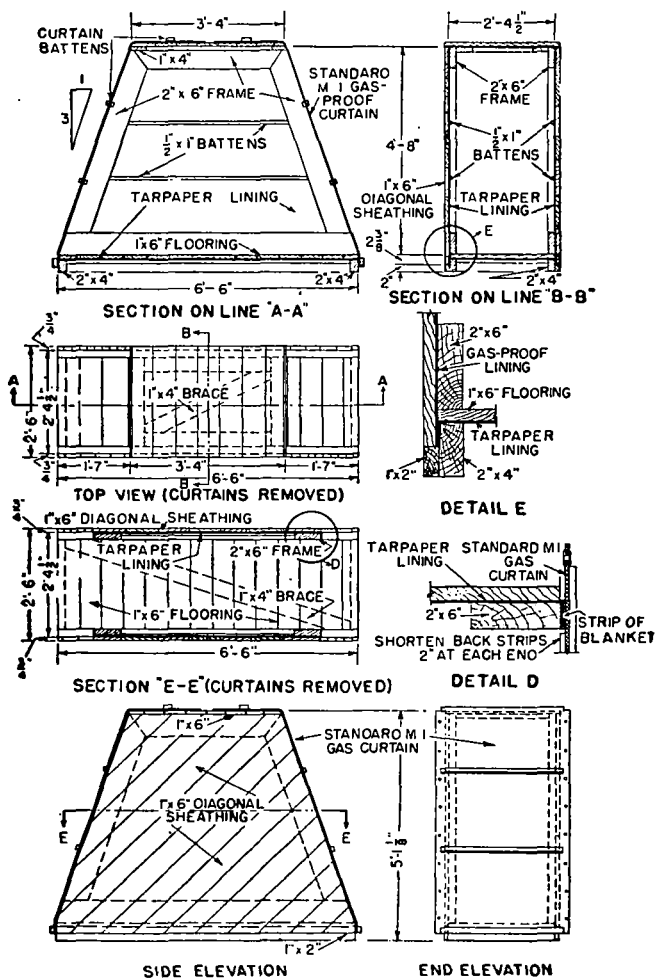


Figure 112. Standard air lock for a shelter.

TABLE IV. *Bill of Materials for a Standard Air Lock*
(Fig. 112)

Item	Size	Unit	Quantity	Weight (pounds)
Frame	2 by 6 inches by 12 feet.....	Each	4	192
Floor frame.....	2 by 4 inches by 10 feet.....	Each	2	55
Floor and sheathing.....	1 by 6 inches.....	Square feet....	95	380
Bracing	1 by 4 inches by 12 feet.....	Each	2	32
Stop strip.....	1 by 2 inches by 14 feet.....	Each	1	9
Gas curtains.....	M1	Each	2	29 (boxed)
Tarpaper	36 inches wide, 108 square feet area.	Roll	1	35
Nails	10d	Pound	5	5
Do	30d	Pound	2	2
Total weight.....				739

*TABLE V. Bill of Materials for Air Lock
for First-Aid Shelters (Fig. 113)*

Item	Size	Unit	Quantity	Weight (pounds)
Floor	2 by 8 inches by 12 feet.....	Each	5	320
Sill	2 by 6 inches by 12 feet.....	Each	2	96
Frame	do	Each	4	192
Do	2 by 6 inches by 10 feet.....	Each	4	160
Sheathing, bracing, and cleats.	1 by 6 inches.....	Square feet...	188	752
Curtain container.....	1 by 6 inches by 12 feet.....	Each	2	48
Curtain frame.....	do	Each	4	96
Do	1 by 2 inches by 12 feet.....	Each	2	16
Gas curtains.....	M 1.....	Each	2	*29
Tarpaper	36 inches wide, 108 square feet...	Each	2	70
Nails	10d	Pound	7	7
Do	30d	Pound	3	3
Total weight				1,789

*Boxed.

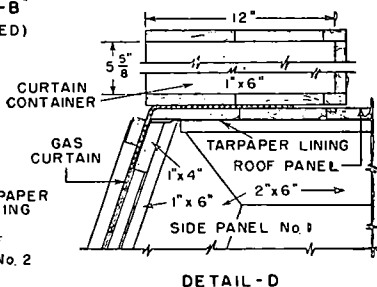
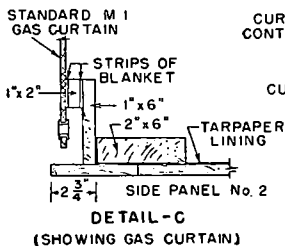
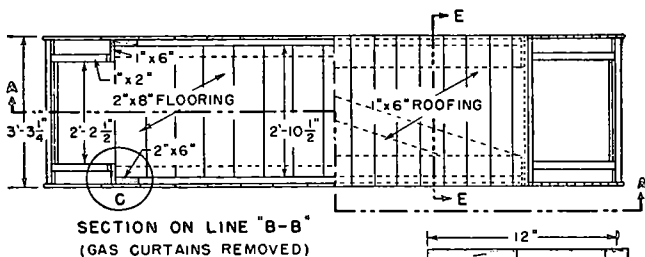
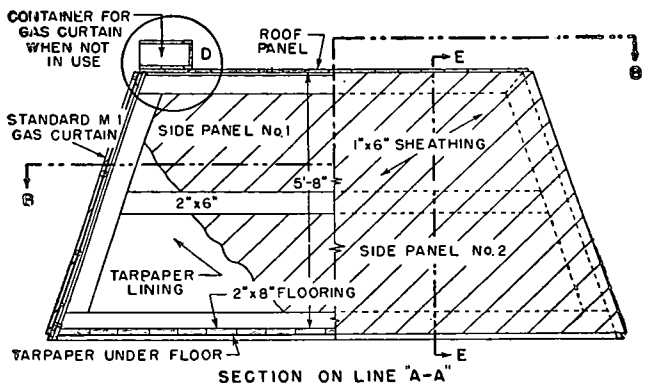


Figure 113. Air lock for a first-aid shelter.

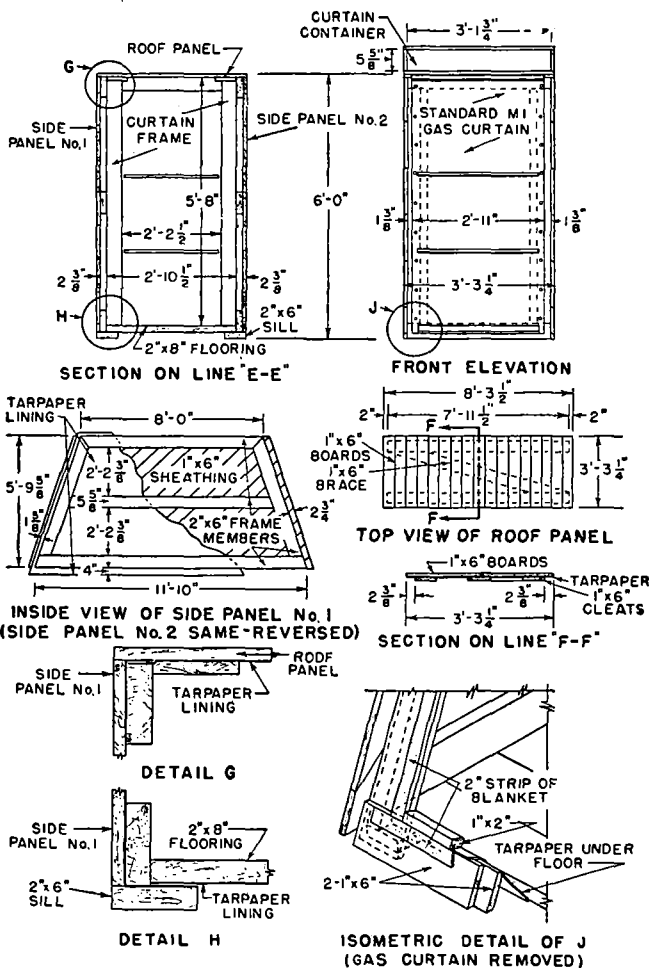


Figure 113. Air lock for a first-aid shelter—Continued.

(5) *Collective protectors.*

(a) These devices are set up outside shelters to purify incoming air by removing chemical agents. Several types are designed to meet specific needs. Most collective protectors are driven by electric motors. Power is provided by a portable generator set, or taken from commercial sources when available. Connected directly with the motor is an air blower which draws outside air through a metal hose or pipe, forces it through a canister for purification, and thence into the shelter. Since concentration of gas invariably is greater near ground level, the air intake should be as high as practicable. The collective protector M1, which is a typical type, has a capacity of 200 cubic feet of air per minute under normal operating conditions.

(b) Collective protectors are obtained from the Chemical Corps, and are installed in shelters intended to be used for a considerable time, such as shelters for command posts, resting troops, and first aid. Only shelters which have been made reasonably airtight should be equipped with collective protectors.

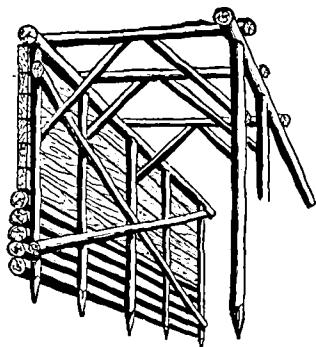
(6) *Sanitary conveniences.* Sanitary conveniences should be provided in all but air-raid emergency shelters and surface-type shelters. Disposal is by chemical closets, septic tanks, or drainage into special sewers.

96. SURFACE SHELTERS. a. **General.** Surface shelters are built only when ground conditions prohibit construction of underground shelters; when there are no buildings, cellars, or other types of existing cover available; and when the situation permits the expenditure of the necessary time and labor. Because surface shelters are above the ground, they are relatively conspicuous and should not, therefore, be built near the front lines unless they can be concealed in woods, on steep reverse slopes, or in other natural defilade. They are constructed of local materials such as saplings, brush, lumber from demolished buildings, cut logs covered with earth, or scrap metal and corrugated metal.

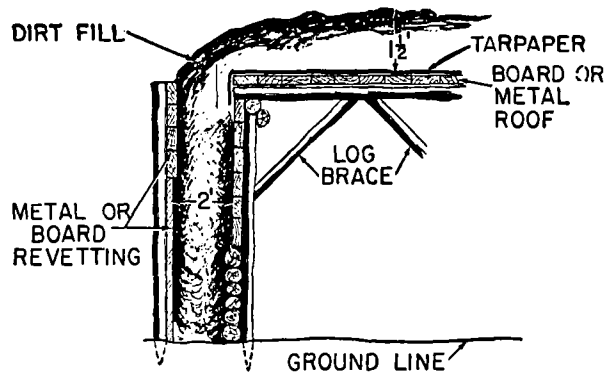
b. **Requirements.** All deliberate surface shelters have three characteristics in common:

- (1) At least $1\frac{1}{2}$ feet of earth, sandbags, packed snow, icecrete or other form of overhead cover; and at least 2-foot-thick outer walls of this material, usually held in place by a revetting of some type.
- (2) A baffle wall in front of the shelter entrance.
- (3) A standard air lock built into the entrance for protection against gas. (See fig. 112 and table IV for details of air lock.)

97. WOOD SHELTERS. Wood surface shelters are built of any cut or uncut timber available. The particular design or dimensions depend upon the builder, except that the inside height should be at least 6 feet. One type of expedient wood shelter is shown in figure 114. A semisurface shelter of cut lumber is shown in fig. 115.



LOG SHELTER FRAME WITH
BOARD OR LOG WALLS



CROSS SECTION OF SHELTER

Figure 114. Expedient wood surface shelter.

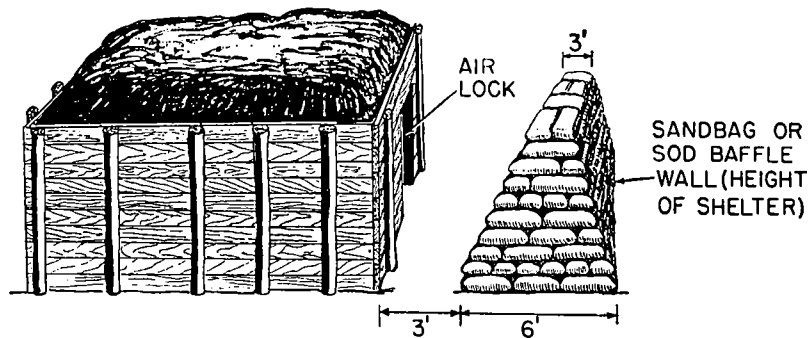
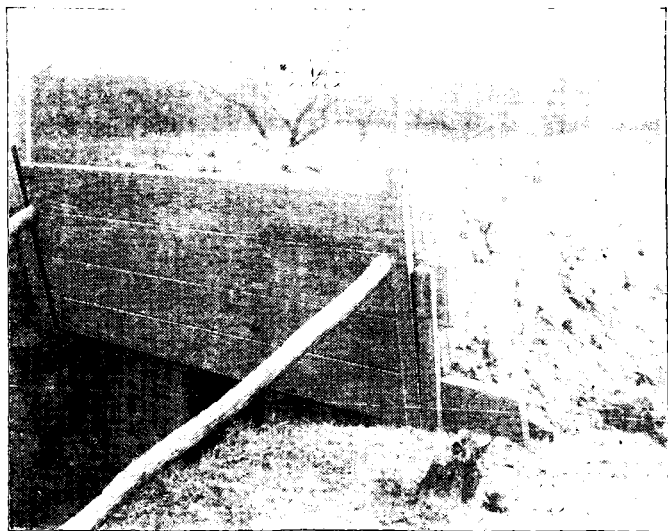
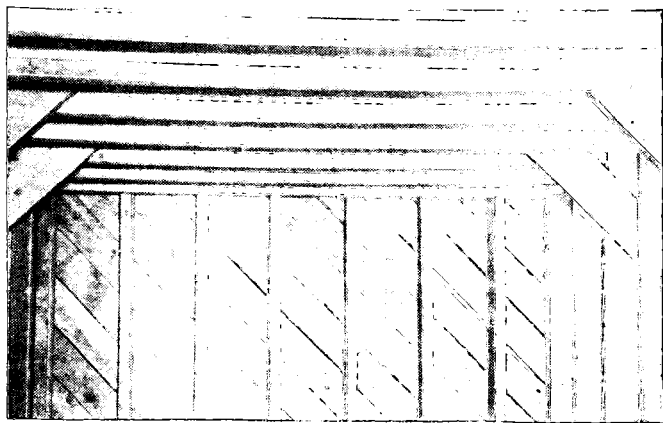


Figure 114. Expedient wood surface shelter—Continued



① Entrance



② Interior

Figure 115. Semisurface shelter of cut lumber.

98. METAL SHELTERS. Metal shelters are superior to wood shelters because they are erected more rapidly, require less outside cover, present smaller targets, and give greater protection from weather; also, the shelter's arch section gives greater resistance to blast, earth shock, and movement. The disadvantages are the use

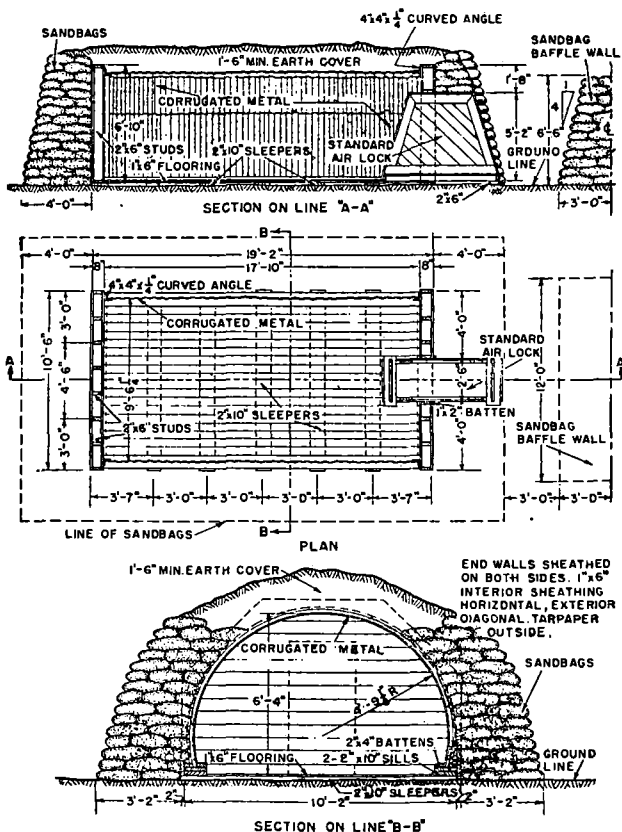


Figure 116. Surface shelter of corrugated metal.

TABLE VI. *Bill of Materials for Corrugated-Metal
Surface Shelter (Fig. 116)*

Item	Size	Unit	Quantity	Weight (Pounds)
Corrugated metal with nuts and bolts.	Standard	{10-foot plate.. }7½-foot plate.	4½{ 4½{	1,977
Sleepers	2 by 10 inches by 18 feet.....	Each	4	480
Sills	2 by 10 inches by 12 feet.....	Each	7	560
Studs, caps, and sills.....	2 by 6 inches by 12 feet.....	Each	13	624
Battens	2 by 4 inches by 18 feet.....	Each	4	192
Floor and end frame sheathing.	1 by 6 inches.....	Square foot ..	500	2,000
Curved angle.....	4 by 4 by ¼ inch by 18 feet....	Each	2	240
Sandbags	Standard	Each	4,050	2,025
Tarpaper	36 inches wide, 108 square feet area.	Roll	2	70
Air lock.....	Standard	Each	1	739
Nails	10d	Pound	11	11
Do	30d	Pound	4	4
Total weight.....				8,922

of a critical material and the transportation of the material to the site. Figure 116 shows a corrugated metal shelter and table VI the bill of materials for its construction.

99. SNOW HOUSES. The size and roof of a snow house are similar to those of a snow pit (par. 92). The side walls, however, consist of snow blocks and may be built up to the height of a man, even with light snow. Snow piled on the outside seals the cracks and camouflages the house (fig. 117).

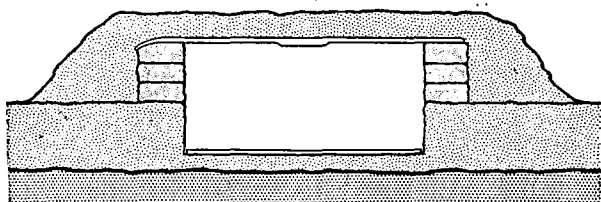


Figure 117. Snow house with ice-block walls.

100. IGLOO. a. General. The Eskimo type of igloo is a very useful shelter and can be built easily if the snow is deep enough and of the right consistency. It is especially valuable in treeless, uninhabited areas, or when tents are not available. Its construction requires practice and familiarity with snow as a material. Film Bulletin 220, "The Arctic Igloo," should be shown to all concerned with building this type of shelter.

b. Description.

- (1) The igloo is a domed house made of snow blocks. It offers protection against wind, cold, rifle and machinegun fire, and shell fragments.

It can be used in many ways: as a shelter, pillbox, dressing station, refrigerator for foods, and shelter for motor vehicles, and can be occupied throughout the winter. The inside temperature of an igloo always is much warmer than the outside temperature, even without heat from fires.

- (2) An igloo can hold from 4 to 50 men, depending on its size ($6\frac{1}{2}$ to 26 feet interior diameter). For a short stay, a small igloo is preferable; for a long stay, a large one. If the snow is of poor quality, several small igloos can be built more quickly than one large one.
- (3) The standard igloo for three or four men has an outside diameter of 8 feet (measured through the thickness of the snow blocks) and an interior diameter of 7 feet; the inside height is 5 feet. The walls are about 8 inches thick, not including the snow piled around the outside. Skilled troops can build it in $1\frac{1}{2}$ hours; unskilled men require 2 to 3 hours.

c. Construction equipment. The following equipment is necessary to construct a three-or four-man igloo:

- (1) One cross-cut handsaw (see fig. 2), or three Eskimo knives with at least 12-inch blades for cutting and trimming snow blocks.
- (2) One hand sled for carrying snow blocks (skis tied together may be used).
- (3) One piece of string, 4 feet long, for use as a ground compass in marking out the location of the first row of snow blocks.

d. Condition of snow. Dry, hard snow, from which snow blocks can be cut quickly, is best suited for building an igloo. Frozen snow is less suitable; fresh powdery snow is useless. The thickness and solidity of snow are tested by probing with a knife. The snow should be at least 12 inches thick. If the snow is less than 12 inches deep and of the proper consistency, large snowballs may be rolled and blocks cut from them. Lower layers under powdery snow may be cut into blocks after the loose snow is removed.

e. Preparation for building. To construct a standard igloo, a center point is fixed and a circle with a 4-foot radius is drawn in the snow with the measuring line on which the foundation for the igloo wall is laid. The site should be leveled, and soft snow packed down or removed. In deep snow, the lower part of the igloo can be dug and a dome built over it.

f. Cutting the blocks.

- (1) The snow blocks are cut out of a pit, the walls of which are vertical and from 12 to 20 inches high. A man standing in the pit cuts out blocks along the edge to obtain perpendicular (not slanting) surfaces. The blocks should be about 2 feet long, 12 to 14 inches wide, and 6 to 8 inches thick (see fig. 118). In cutting the blocks, a small trench is dug out along one side of the pit so the blocks may be lifted out easily.
- (2) Blocks should be lifted out carefully to avoid damaging their surfaces. The speed of building depends essentially on the speed at which the blocks can be cut. Therefore, men charged

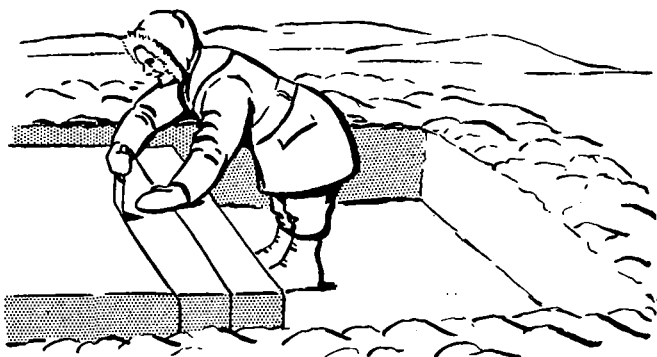


Figure 118. Cutting snow blocks for an igloo.

with this task must be relieved frequently. The blocks are transported to the building site on a sled or are carried carefully by hand.

g. Building the walls. The blocks are placed on the circle drawn in the snow so that the long edge of the block is resting on the ground. The blocks are slanted inward and the ends trimmed with a knife so that each block is flush against the next. Cracks are filled with loose snow. When the first row of blocks has been laid, a triangular cut is made in one block and its surface slanted at an angle so that when the second row is laid on the first it forms a spiral (figs. 119 and 120). Successive tiers of blocks are laid in this manner, spiraling upward and slanting increasingly inward. Trimming with the knife assures a good, firm bit of one block upon another.

h. Completing the dome. As the structure grows higher, the diameter of the tier diminishes sharply and the blocks slant more toward the center of the circle. At this stage, all blocks must be cut especially clean and

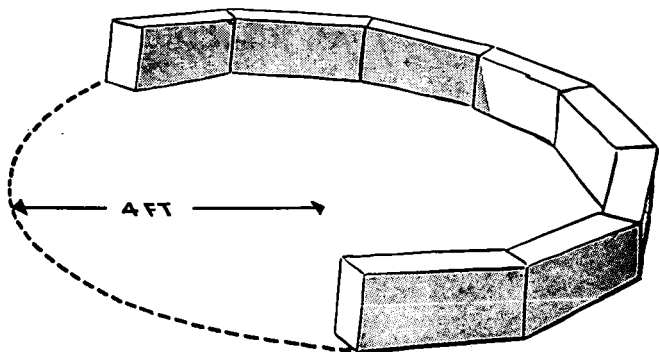


Figure 119. Part of the first tier of the igloo.

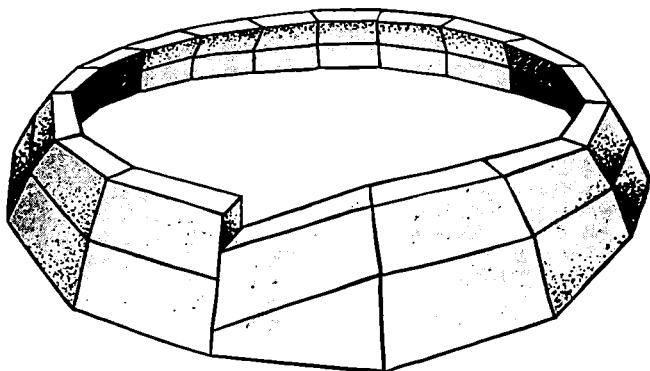


Figure 120. Spiral design of second tier of snow blocks.

even, so a good fit is obtained. Up to about two-thirds of the height of the igloo, construction difficulties increase; then they decrease because the tiers become almost self-supporting as they grow smaller. The final block which completes the dome is placed on and then trimmed from inside to fit snugly (fig. 121). It is important to cut the last block carefully, as the tight fit of this block keeps the others from falling out.

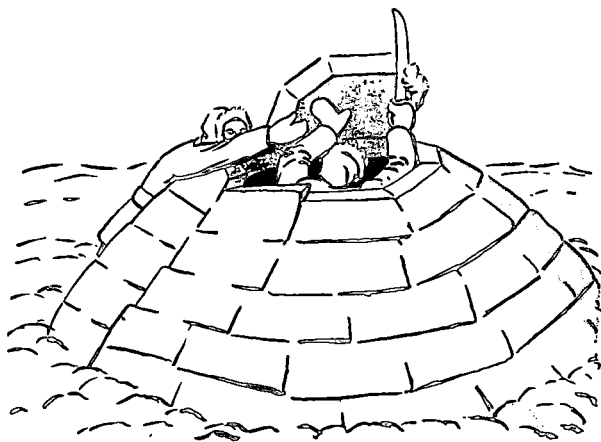


Figure 121. Completing the dome.

i. **Finishing touches.** Blocks protruding on the inside are smoothed down. The entrance is cut out at the base of the igloo with the knife and is merely a round or oval opening. Tunneling an approach to the entrance through deep snow provides more room for entering (fig. 122). The outside of the igloo is left rough to provide a holding surface for a cover of snow, which fills in the cracks and further strengthens the structure. The snow cover is made to serve a double purpose around the lower part of the igloo. Banked to a gentle slope, the snow provides protection against rifle fire and shell fragments. It also camouflages the igloo, giving it the appearance of a snowdrift. To admit light, a hole may be cut into the wall. The final inch is shaved down carefully with a knife so a thin, transparent sheet of ice remains as a window.

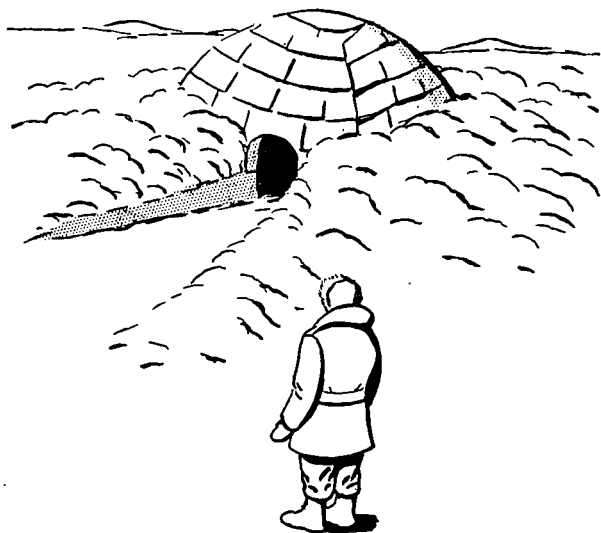


Figure 122. Entrance to igloo.

j. Furnishings.

- (1) The snow floor of an igloo is covered with insulating materials. Branches of birch, willow, larch, fir, pine, dry leaves, underbrush, boards, heather, dry moss, hay, straw, paper, cardboard, animal skins, shelter halves, woollen blankets, sleds, and skis are suitable. Layers with plenty of air space between them are excellent (for instance, alternate layers of shelter halves and brushwood).
- (2) The igloo can be heated to more than 65° F. with cooking apparatus, kerosene lamps, or candles. It is better, however, not to increase the air temperature at head level to more than 41° F. This keeps the snow dry and retains

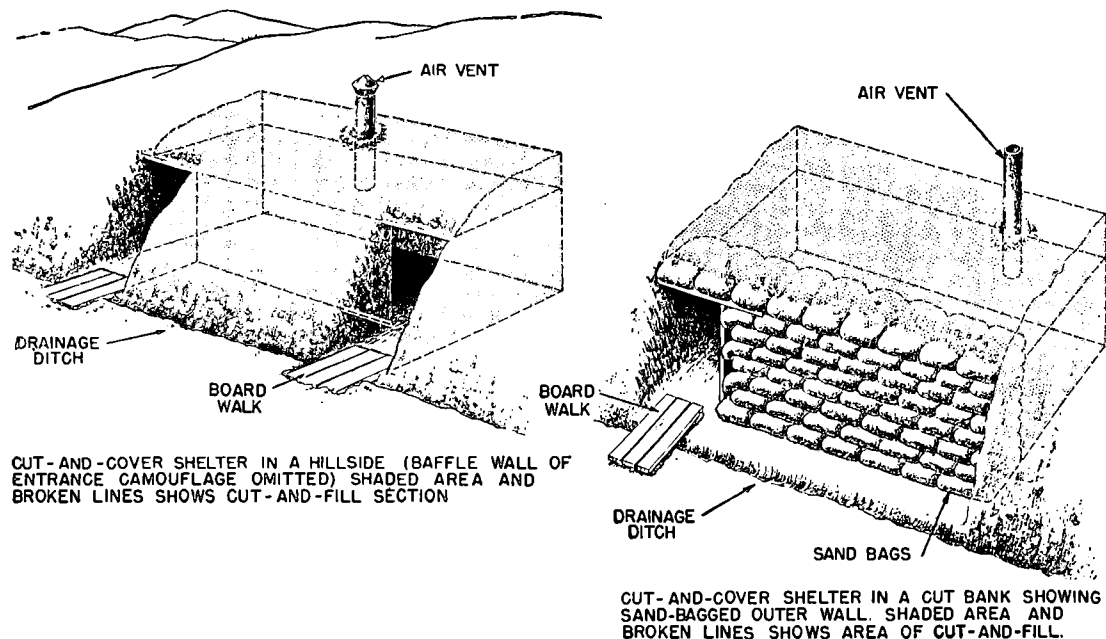


Figure 123. Cut-and-cover shelters

air for a longer period of time. The dome must be protected against rising heat from the lamps. If the interior of the dome becomes glazed with ice, it must be scraped off and more snow added on the outside.

- (3) If the igloo is smooth inside and nothing protrudes from the walls, melting snow will not drip but will run along the walls.
- (4) Before retiring at night, the occupants of the igloo must close the entrance with snow blocks, shelter halves, or tarpaulin.

101. CUT-AND-COVER SHELTERS. *a.* If time, labor, and materials are available, cut-and-cover shelters are the

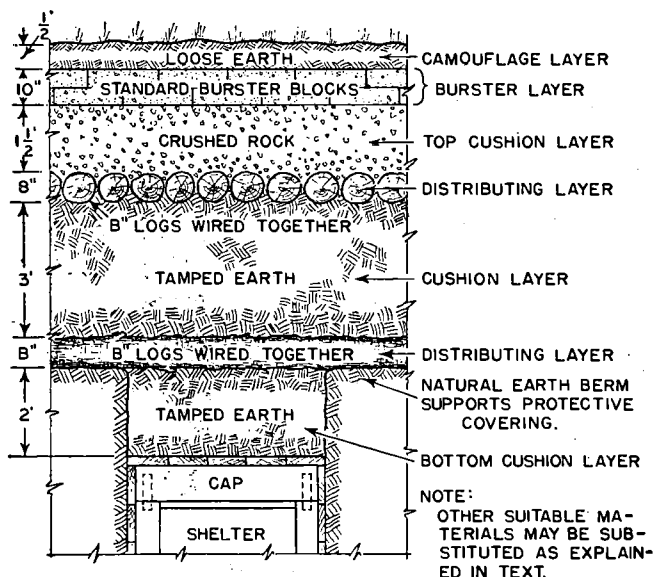


Figure 124. Overhead cover for cut-and-cover shelters.

most desirable. They offer more protection from enemy fire than surface shelters and take less time and effort to excavate than deliberate cave shelters. Cut-and-cover shelters are best sited by excavating on a reverse slope of a hill, mountain, ridge, or steep bank, as shown in figure 123. The shelter frame of lumber, uncut timber, or corrugated metal is built in the excavation; the spoil is backfilled around and over the frame to ground level, or somewhat above, and camouflaged. (See fig. 123.)

b. The protection offered depends upon the type of construction and the overhead cover (par. 19). The type of overhead cover desirable varies with the geographical location. Some examples are shown in figures 19, 20, 21, 98, 99, 124 and 125.



① Concrete and dirt

Figure 125. Two types of overhead cover for cut-and-cover shelters.



② Log and dirt

Figure 125. Two types of overhead cover for cut-and-cover shelters—Continued.

c. For drainage, the floors of the shelter slope slightly toward the entrance. Excavation should be no greater than necessary to accommodate the shelter, and dirt should be packed tightly around the frame.

102. WOOD SHELTERS. Cut-and-cover shelters usually are constructed with wood and are similar in design to surface shelters. A cut-and-cover shelter is built in an excavation and covered over with spoil. The deeper the overhead cover, the stronger the frame and room must be. One type of cut-and-cover log shelter is shown in figure 126; the bill of materials is given in table VII.

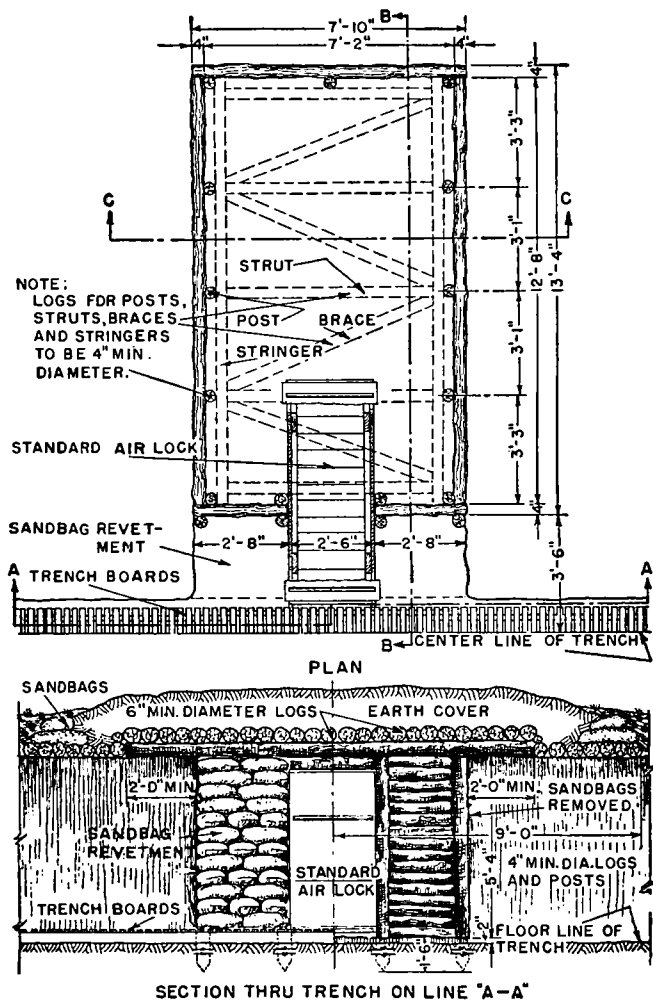


Figure 126. Log cut-and-cover shelter.

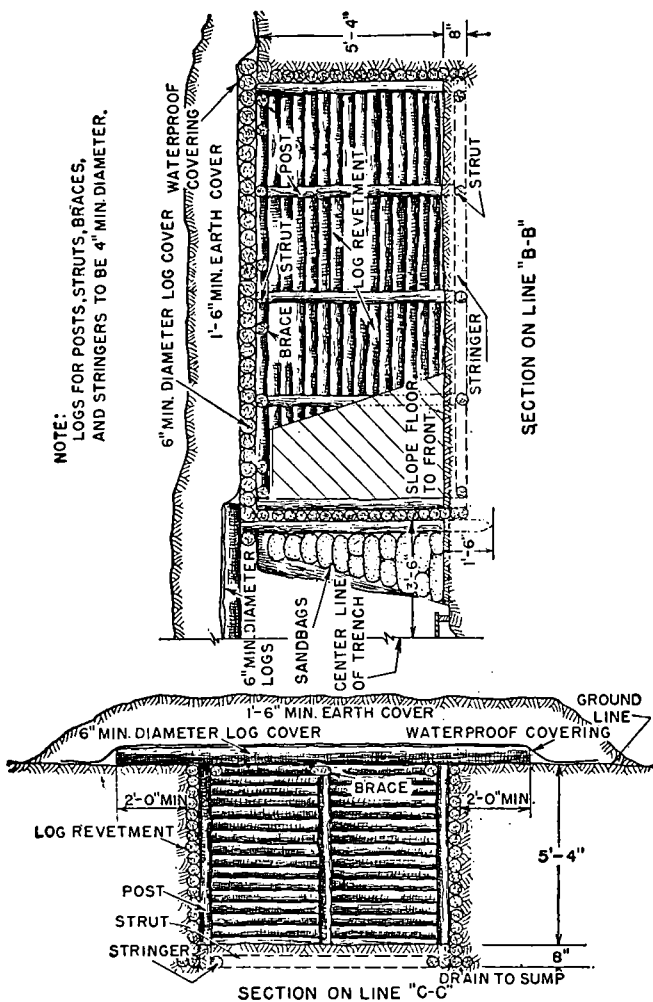


Figure 126. Log cut-and-cover shelter—Continued.

TABLE VII. Bill of Materials for Cut-and-Cover
Log Shelter (Fig. 126)

Item	Size	Unit	Quantity
Struts, floor and roof.....	4 inches minimum diameter by 5 feet 10 inches.....	Each	10
Stringers, floor and roof.....	4 inches minimum diameter by 12 feet 8 inches.....	Each	4
Bracing, roof, to cut.....	4 inches minimum diameter by 6 feet 6 inches.....	Each	4
Posts, frame only.....	4 inches minimum diameter by 6 feet 0 inch.....	Each	13
Posts, face of shelter.....	4 inches minimum diameter by 7 feet 4 inches.....	Each	4
Walls, side.....	4 inches minimum diameter by 12 feet 8 inches.....	Each	34
Wall, end.....	4 inches minimum diameter by 7 feet 10 inches.....	Each	18
Wall, front.....	4 inches minimum diameter by 2 feet 8 inches.....	Each	36
Roof	6 inches minimum diameter by 12 feet 0 inch.....	Each	1
Air lock.....	Standard	Each	1
Roofing nails	10 gage, 1 inch long.....	Pound	1
Nails	.60d	Each	75
Tarpaper	36 inches wide, 108 square feet area.....	Roll	6
Sandbags	Standard	Each	150

The drawing consists of two parts: a plan view at the top and a section view at the bottom.

Plan View: Shows the top-down layout of the trench. The overall width is 10'-6" and the length is 13'-0". The structure is built with 2x4 studs, 1x6 horizontal sheathing, 1x6 flooring, and 2x12 sleepers. It features 4 standard 10'-0" full plates and 4 standard 2'-6" full plates. The structure is bolted or nailed to a frame wall and corrugated metal. The plan view also shows the center line of the trench and the location of the standard air lock.

Section on Line A-A: Shows a cross-section of the trench. The structure is built with 1x6 roof sheathing, 1x6 minimum earth cover, 2x6-2'-0" D.C. (Double C), 1x6 diagonal sheathing, and 1x6 horizontal sheathing. It features a standard air lock and is surrounded by trench boards. The section view also shows the ground line, the outline of the corrugated metal, and the floor line of the trench.

Figure 127. Corrugated-metal cut-and-cover shelter.

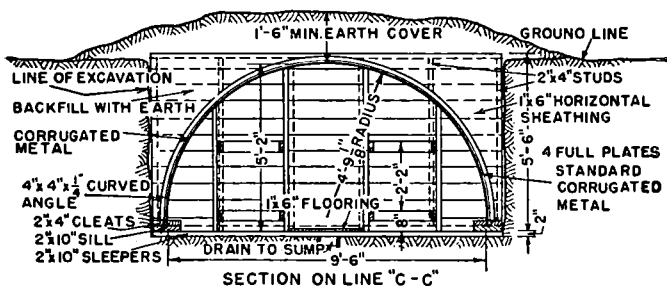
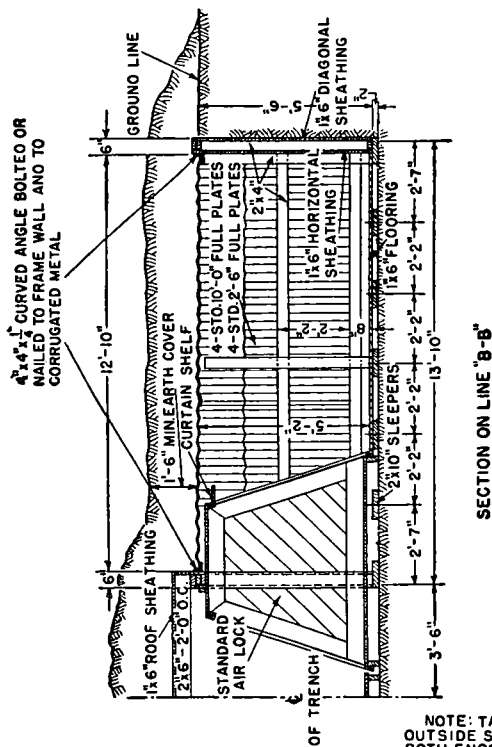


Figure 127. Corrugated-metal cut-and-cover shelter—Continued.

*TABLE VIII. Bill of Materials for Corrugated-Metal
Cut-and-Cover Shelter (Fig. 127)*

Item	Size	Unit	Quantity	Weight (pounds)
Corrugated metal with nuts and bolts	Standard	{2½-foot plate. 10-foot plate..	4} 4}	1,260
Sills	2 by 10 inches by 14 feet.....	Each	2	187
Sleepers	2 by 10 inches by 12 feet.....	Each	7	560
Studs, caps, and sills.....	2 by 4 inches by 12 feet.....	Each	10	320
Cleats	2 by 4 inches by 14 feet.....	Each	4	149
Bunk frames	do	Each	14	523
Floor and sheathing.....	1 by 6 inches.....	Square foot ..	305	1,220
Curved angle.....	4 by 4 by ¼ inch by 15 feet 4 inches	Each	2	204
Tarpaper	36 inches wide, 108 square feet area	Roll	2	70
Nails	10d	Pound	17	17
Do	30d	Pound	6	6
Air lock	Standard	Each	1	739
Staples, bunk	⅞-inch, No. 9.....	Pound	5	5
Wire, galvanized, bunk.....	10-gage	Linear foot ..	190	6
Wire netting, bunk.....	72 inches wide, 2-inch mesh.....	Linear foot ..	33	17
Total weight				5,283

of, and materials for, a large corrugated-metal cut-and-cover shelter.

104. CAVE SHELTERS. a. General.

- (1) Caves are permanent shelters for supplies and personnel. They are constructed in deliberate defensive positions when the time, materials, and labor are available. Normally, cave shelters are dug in one of two ways: either tunneled into hillsides, cliffs, cuts, and ridges by mining methods, or excavated into flat ground by digging two inclines down to the desired depth and connecting the two with a subterranean chamber.
- (2) Because of the undisturbed overhead cover, a cave is the least conspicuous of all types of shelters if the entrance is covered. Caves afford effective protection even when only partly complete. They are, however, the most difficult type of shelter to dig and usually are the most difficult to drain.

b. Spoil. The spoil from caves is disposed of carefully. In positions where the cave-shelter entrance leads down from the trench, the spoil can be used for parapets, breastworks, and the like.

c. Entrances.

- (1) Since cave entrances are visible to aerial observers, they must be camouflaged. One of the best locations for a supply-cave entrance is shown in figure 128. Vehicles can be driven directly into the cave from the road.

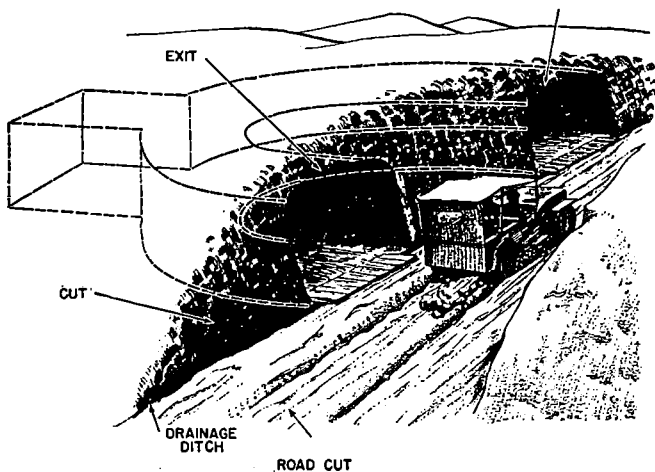


Figure 128. Supply-cave entrances in a road-cut.

- (2) In flat terrain where ground conditions permit construction of a cave-type excavation, an inclined entrance is dug into the ground to the desired depth at an angle of 45 degrees. Steps are cut into the incline and reinforced with wooden bracing. (See fig. 129.)
- (3) For large shelters, at least two inclined entrances are constructed, one at each end of the chamber for easy exit and in case one entrance is bombed shut or closed in some manner.

d. Construction.

- (1) *Removing dirt.* One quick way of removing the earth when excavating a cave is to rig up an endless belt system in the incline. The upper end of the belt is attached to the rear

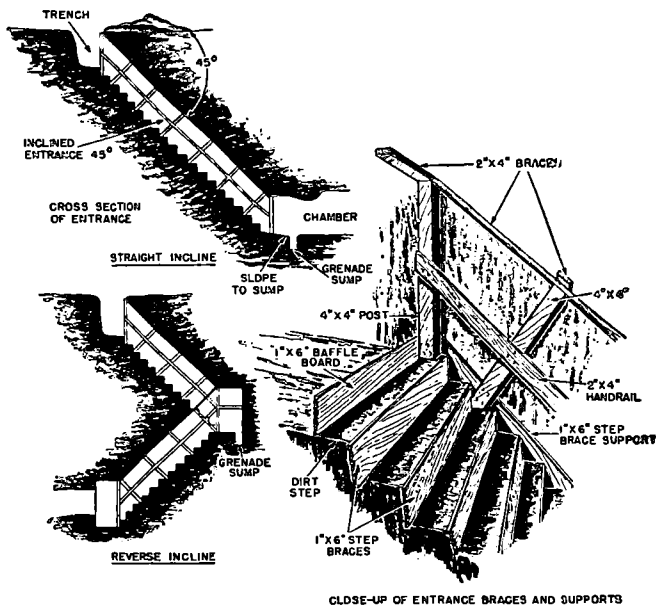


Figure 129. Inclined entrances to cave shelters.

wheel of a jeep or truck. Should the entrance curve or change direction, the endless belt system will not work in the incline. However, a shaft may be sunk straight down to intersect the incline at the desired depth and then an endless belt or bucket system can be rigged up in the shaft. (See fig. 130.)

- (2) *Chamber shape.* The chamber at the end of the incline may be any shape desirable. However, a long narrow chamber is better than a short wide one because the weight of the overhead earth is distributed over a greater area instead of being concentrated on one spot.

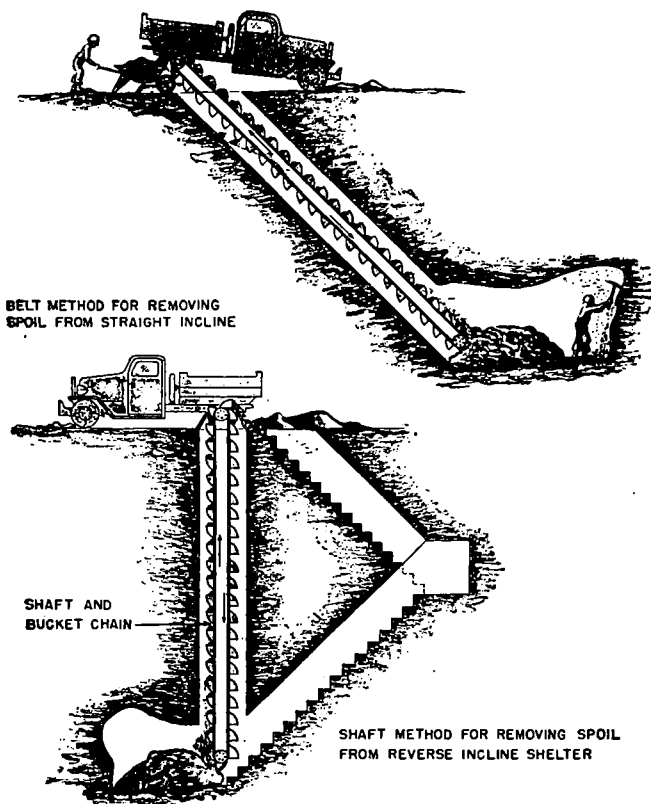
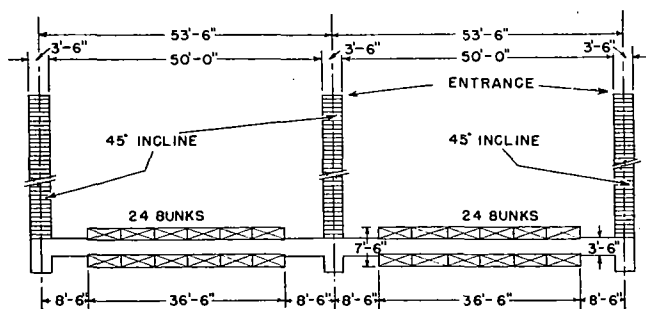
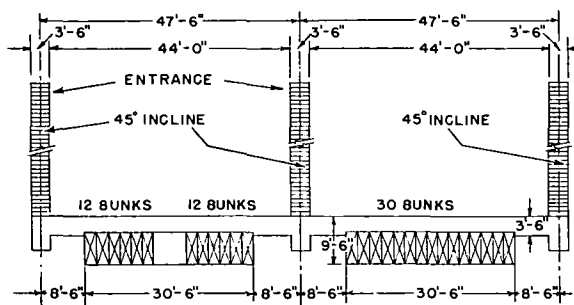


Figure 130. Removing dirt from cave shelters.

e. **Typical cave shelters.** An example of a gallery-type and a recess-type cave shelter for personnel is shown in figure 131. Diagrams for a gallery-type cave shelter for personnel are shown in figure 132. The bill of materials for this shelter is given in table IX.

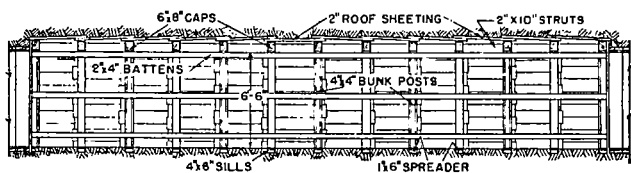


GALLERY TYPE

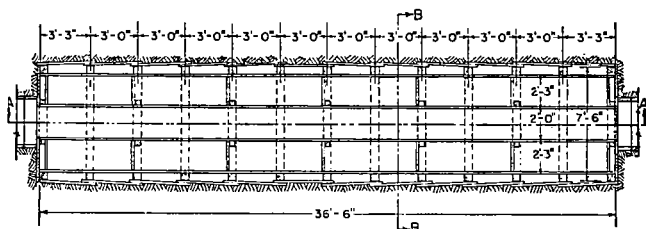


RECESS TYPE

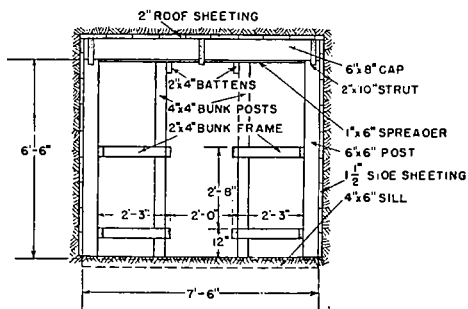
Figure 131. Plan view of a gallery-type and a recess-type cave shelter for personnel.



SECTION ON LINE "A-A"



PLAN



SECTION ON LINE "B-B"

Figure 132. Gallery-type cave shelter.

TABLE IX. *Bill of Materials for Gallery-Type
Cave-Shelter Chamber (Fig. 132)*

Item	Size	Unit	Quantity ¹	Weight (pounds)
Gallery frames	Great	Each	13 (2)	4,680
Posts, bunk	4 by 4 inches by 8 feet.....	Each	14 (2)	600
Struts	2 by 10 inches by 8 feet.....	Each	12 (2)	640
Bunk frame, crosswise, to cut...	2 by 4 inches by 8 feet.....	Each	7 (1)	148
Bunk frame, lengthwise.....	2 by 4 inches by 14 feet.....	Each	25 (4)	932
Battens	2 by 4 inches by 12 feet.....	Each	7 (1)	224
Sheeting: top ²	2 by 10 inches by 4 feet.....	Each	66 (11)	1,760
Do	2 by 8 inches by 4 feet.....	Each	22 (4)	470
Do	2 by 6 inches by 4 feet.....	Each	30 (5)	480
Do	2 by 4 inches by 4 feet.....	Each	45 (7)	120

Sheeting, side ²	1½ by 10 inches by 4 feet	Each	132 (22)	2,640
Do	1½ by 8 inches by 4 feet	Each	44 (8)	701
Do	1½ by 6 inches by 4 feet	Each	60 (10)	720
Do	1½ by 4 inches by 4 feet	Each	90 (14)	720
Sheeting, ends ²	1½ by 10 inches by 4 feet	Each	22	440
Do	1½ by 8 inches by 4 feet	Each	8	128
Do	1½ by 6 inches by 4 feet	Each	10	120
Do	1½ by 4 inches by 4 feet	Each	14	112
Wedges	Standard	Each	145 (24)	203
Wire netting, bunk	72 inches wide, 2-inch mesh	Linear feet	100 (30)	50
Wire, galvanized, bunk	10-gage	Linear feet	600 (100)	30
Staples	⅞-inch, No. 9	Pound	12 (2)	12
Nails	10d	Pound	6 (1)	6
Do	30d	Pound	6 (1)	6
Total weight				15,965

¹Figures in parentheses show quantities required for unit length of 6 feet.

²Sheeting of different width may be substituted for that shown, but an equivalent total width of sheeting must be furnished.

CHAPTER 4

BARRIER TACTICS

Section I. OBSTACLES

105. GENERAL. a. In this discussion of barrier tactics, the term "obstacle" refers only to obstacles erected by ground troops to impede enemy offensive movement. Obstacles may be created by the Air Force in the enemy's rear areas to impede movement of troops and supplies, and disrupt communications. This usually is done by bombing. A tactical obstacle is any natural terrain feature, condition of soil or climate, or any man-made object or works, other than fire power, used to stop or divert enemy movement. *To be most effective, all obstacles must be covered by fire.* The construction of obstacles for close-in defense is the responsibility of troops occupying the area. Engineer troops furnish technical advice and assistance. Works which require special skill and equipment, which protect exposed flanks or rear, or which benefit the command as a whole are the responsibility of engineer troops. Engineer troops may be called upon to construct defensive positions before arrival of the occupying troops who normally site the individual emplacements; general plans for the positions are outlined by higher authority.

b. Obstacles are classified as natural or artificial.

- (1) Natural obstacles include steep slopes, streams, gullies, canyons, lakes, swamps, heavy

woods, thick jungle and undergrowth, deep snow, and man-made objects such as buildings or walls not originally erected to serve as obstacles but which may be employed as such.

- (2) Artificial obstacles include demolished bridges, road craters, abatis, flooding lowlands, mine fields, wire entanglements, road blocks, anti-tank ditches, and log, steel, or concrete structures.

106. EMPLOYMENT. Obstacles are used in *offensive* and defensive situations, in *denial* operations, and in *retrograde* movements. Natural obstacles are improved and artificial obstacles are placed to break up enemy attack formations, delay him, restrict his power to maneuver, and hold him in areas covered by intense defensive fires, particularly those of automatic weapons and antitank guns. Obstacles are placed so they are inconspicuous from enemy observation and so well-sited defensive fire can prevent their neutralization by the enemy.

a. Antipersonnel obstacles.

- (1) Barbed-wire entanglements, trip flares, noise makers, and antipersonnel mines are sited to warn against enemy patrol action or infiltration at night, and to prevent the enemy from delivering a surprise assault from positions close to the defenders. Such obstacles must be near enough to defensive positions for adequate surveillance by the defenders by night and day and yet far enough away to prevent the enemy from lying beyond the obstacles and effectively using grenades.

- (2) Booby traps are employed as a harassing or nuisance obstacle and to deny advancing troops immediate access to buildings, installations, and abandoned equipment. Booby traps are particularly effective against souvenir hunters and looters.

b. Antimechanized obstacles. Mine fields, antitank ditches, concrete, log, and steel structures are employed to immobilize, or to halt or delay wheeled and tracked vehicles long enough for antitank fire to destroy them.

c. Field fortifications. Both antipersonnel and anti-mechanized obstacles are employed to protect field fortifications. Obstacles for permanent fortifications usually are extensive concrete and steel structures which require considerable time and material to construct. They usually are built around strategic installations in rear areas or around defensive works erected in peacetime.

d. Obstacles to landing of airborne troops. The threat from troops landed by parachute, aircraft, or glider requires that special security measures be instituted against them. These measures include the use of obstacles on landing fields and possible parachute dropping zones. Effective obstacles include craters, barbed wire, posts solidly implanted in a vertical position, immobilized vehicles, rock-filled oil drums, mine fields, and felled trees. (See fig. 133.)

e. Beach and underwater obstacles. Positions on the coast line and on the banks of rivers where enemy waterborne landings are likely to occur, are prepared for such emergencies by emplacing mined posts, piles, steel



Figure 133. Antiglider or parachute obstacles.

and concrete obstacles, barbed wire, and mines under water and along beaches to hinder the beaching of invasion craft. Figure 134 shows a barrier defense system for a coastal area; all types of obstacles are employed.

Section II. BARRIERS

107. GENERAL. a. Definitions.

- (1) *Barrier.* A continuous series of natural and artificial obstacles across an expected avenue of enemy approach.
- (2) *Barrier system.* A series of related barriers and obstacles in an area.
- (3) *Covering barrier.* A barrier in front of the main battle position.

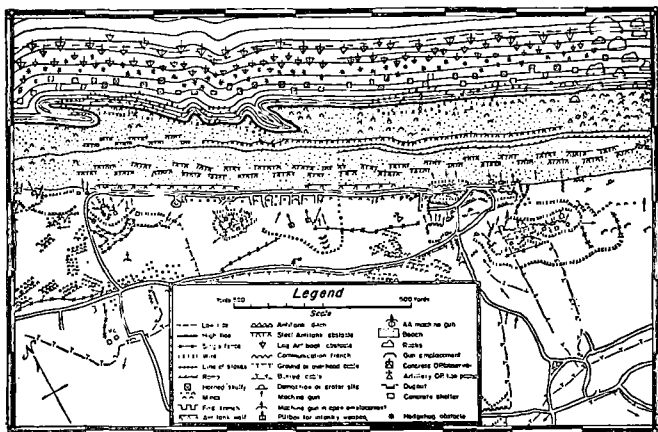


Figure 134. A complete barrier defense system against seaborne and land attack.

- (4) *Flank barrier.* A barrier protecting a unit's flank.
- (5) *Rear-area barrier.* A barrier blocking routes in the rear of the main battle position.
- (6) *Barrier tactics.* Tactics based on the use of barriers defended by artillery, antitank weapons, or machine-gun fire to prevent or hinder enemy advance in an area. Figures 134 and 135 show examples of some types of barriers.

b. Exploitation of natural obstacles. In ordinary situations, construction of artificial obstacles is restricted by the quantities of labor and materials required. Therefore, barriers must exploit natural obstacles to the utmost. Demolition of bridges over unfordable streams and extensive use of mine fields to close gaps between



Figure 135. Barriers: A, low-wire entanglement; B, band of concertina; and C, line of tank traps, antitank walls, and wire.

natural obstacles is the most practical method of constructing a zone of obstacles.

c. Defense of obstacles. Engineers normally are included in the forces employed in barrier operations. Although combat engineers are equipped to defend as well as construct obstacles, other troops should take over the defense to free the engineers for other engineering work. Any troops used must be mobile and well equipped with automatic and antitank weapons and communication facilities.

d. Execution of prepared demolitions. Demolitions to close gaps in a band of obstacles frequently are prepared in advance and are executed when the tactical



① Drilling charge holes in bridge abutments.



② Engineers placing satchel charges on a treadway bridge.

Figure 136. Preparing bridges for demolition.

situation demands (fig. 136). Responsibility for executing demolitions in flank or covering barriers usually is delegated to the commander of the covering force. Higher commanders normally control demolitions in rear-area barriers because of the serious consequences of prematurely blocking the road net. As demolitions must be exactly timed, particularly in retrograde movements, demolition orders must be clear and specific. Depending on the situation, they usually are to be executed—

- (1) Immediately.
- (2) At a stated time.
- (3) Only when necessary to keep site from falling into enemy hands.
- (4) Only when ordered by designated commander or when necessary to prevent capture.

FM 5-25 contains detailed information on breaching of obstacles, including formulas for placing charges.

108. EMPLOYMENT OF BARRIERS. a. Defense. Barriers are used in defensive or retrograde movements to—

- (1) Delay initial enemy advance toward the front or flank of a position.
- (2) Impede maneuverability of an enemy penetrating or enveloping force.
- (3) Hamper enemy pursuit.
- (4) Canalize enemy penetrations into desired avenues of approach.
- (5) Permit withdrawal of troops from one area so they can be concentrated at point of expected attack.

b. Offensive. Barriers are used offensively to—

- (1) Provide flank security.
- (2) Guard against surprise counterattack.
- (3) Protect section of front which is not strongly held.

c. Flank and covering barriers. Because of their location, flank and covering barriers can be erected in advance without much interference with military installations. The number of gaps left through these barriers depends on the likelihood of friendly troops later advancing over the same terrain. The possibility of counterattacks, both friendly and enemy, appreciably affects the location of obstacles.

d. Rear-area barriers.

- (1) Rear-area barriers are used to delay enemy mechanized forces and weaken them by attrition; to canalize their advance into avenues favorable to counterattack; and to provide local protection to vital installations. They block possible enemy movements without interfering with normal friendly traffic or with counterattacks.
- (2) Materials and labor available generally limit rear-area barriers to prepared bridge demolitions and well-sited road blocks. Plans are made for rapid laying of mine fields to meet possible threats. All avenues of approach are covered. Since active defense means are rarely adequate to protect all rear-area installations at once, vital installations are located in areas organized for all-around defense and their protection is planned with reference to natural obstacles and other parts of the barrier system.

109. PLANNING OF BARRIERS. The higher commander prepares the broad barrier plan based on exhaustive terrain study and the overall tactical plan. Obstacles constructed by division and lower units must fit into this general outline. Obstacles and weapons in adjoining areas are coordinated with plans for operations in the entire area. This applies especially in locations where counterattacks are planned, friendly motorized or mechanized units are to operate, or administrative activities are to take place. The plan goes through the following steps:

a. Army commander. The army commander's instructions include—

- (1) Broad barrier plan for army area, including key bands.
- (2) Assignment of tasks to subordinate units. Covering forces construct covering barriers, and security forces on open flanks erect flank barriers. Army and corps troops install rear-area barriers.
- (3) Limitations on use of obstacles in any particular area to insure coordination into general plans. Mines in particular must not be laid without proper authority.
- (4) Emphasis on need for secrecy. Precautions must be taken to safeguard charts and maintain security of barrier plan. Broad plan should not go below division.
- (5) Location of main supply route.

b. Corps commanders. Instructions issued by the corps commander are based on a thorough and complete terrain study and reconnaissance by corps reconnaissance agencies. They include—

- (1) A detailed barrier plan for the corps area, covering—
 - (a) Location of natural and artificial barriers, including major mine fields.
 - (b) Location of lanes to be left open for counterattack plans and supply.
- (2) Assignment of tasks to subordinate units including divisions and corps troops.
- (3) Close coordination of division plans.
- (4) Detailed siting of corps flank barriers.
- (5) Maps or overlays showing plan in enough detail so lower units will know exactly which barrier lines are to be installed or reinforced.

Note. When operating independently of army, the corps commander's instructions also include those outlined for army commanders.

c. Division commanders. Division commander's instructions cover—

- (1) Plan of barriers of obstacles and purpose each is to serve.
- (2) Timetable and priority of construction.
- (3) Demolition orders.
- (4) Routes to be kept open in accordance with tactical plan.
- (5) Need for secrecy. Detailed plan should not be in hands of front-line units.
- (6) Limitations on use of chemical agents.
- (7) Assignment of troops and equipment for construction and defense.

110. ACTION OF UNIT ENGINEER. The unit engineer of a subordinate unit plans the details of the barrier to fit the plan of the higher commander. He develops the

program as follows:

a. Map study. By studying available maps and aerial photos and from previous reconnaissance and knowledge of the terrain, he determines all natural obstacles useful to his mission and locates obvious gaps and defiles.

b. Reconnaissance. Supplements map study by directing a detailed ground reconnaissance. Locates accurately individual obstacles required and determines type obstacle to be used in each case. Estimates time, labor, and materials needed.

c. General plans. Based on above, he indicates a plan on the map in graphic form, including location of each obstacle band and location and type of principal obstacles in the band. Prepares table of priority of construction, including time, labor, and material estimates. Tabulation may show that time, labor, or material limitations do not permit completion of the mission. The plan as finally approved must fit into the tactical commander's plans for entire unit.

d. Detailed plans. Prepares detailed plans and orders. Subdivides work, assigns tasks to units, and issues orders. Even when tactical situations demand that work be started before plans are completely developed, the above steps must be considered.

e. Report. Submits report of completed obstacles. Since obstacles restrict movement of friendly as well as enemy troops, units placing obstacles must immediately report their location to next higher commanders. If there is any possibility that adjacent troops may operate in the vicinity of the obstacles, they also are notified to insure coordination.

CHAPTER 5

MINE FIELDS

111. GENERAL. a. Because land mines are portable, easily and quickly installed and camouflaged, and easily removed, if carefully charted, they are the best of all artificial obstacles. Mine fields must be recorded for protection of friendly troops (except as indicated in par. 114a).

b. In winter, however, the obstacle effect of mines is diminished, becoming nonexistent if snow is 10 to 12 inches or more deep. To offset the sinking of mines in snow, they are laid on boards or other broadsurfaced support. In general, pull-action igniters are installed in mines laid in snow because they are more effective than pressure-type igniters; however, neither are entirely reliable when mines are buried under the snow because the igniters are likely to freeze up.

112. EMPLOYMENT OF MINES. Land mines are employed to slow down or stop enemy armor, wheeled vehicles, and foot troops; inflict casualties on enemy personnel; restrict movement; and delay the enemy under concentrated and planned fire. Mines may be used as obstacles, as a warning for local security of positions or working parties, as road blocks, or installed in deep belts as forward protection of defense lines. (See FM 5-31 for detailed information on mine tactics.) Mine fields are laid under the three general tactical considerations given below.

a. Organizing an objective. When organizing a captured objective, the primary consideration is to lay an antitank mine field to improve the antimechanized defense against any counterattacks. If standard drill is used, a marking fence is set up and accurate records kept of the pattern and number of mines laid. If recording is not possible because of the situation, and the field must be breached by friendly troops at a later date, the area then is treated as an enemy field and gapped by deliberate methods.

b. Assuming the defense. When changing to the defensive, the unit occupying the ground lays mines and records them as they are laid. All likely routes of enemy approach are blocked in this manner and supplemented with other obstacles if time permits.

c. Deliberate defense. In deliberate defensive positions, extensive mine fields are laid under engineer supervision and are recorded accurately by engineers.

d. Use of mines for temporary security. Reconnaissance units, security guards for working parties, or other isolated units may lay mines to block any avenue of enemy approach, to eliminate enemy surprise attacks, and to supplement the fire of certain weapons.

113. TYPES OF MINES. a. General. There are two types of land mines, antitank and antipersonnel. The two types may be employed separately; or, when both types are used in the same mine field, one protects the other.

b. Antipersonnel mines. Antipersonnel mines (see fig. 137) are used primarily around forward positions and outposts to break up or hinder enemy patrol action, and to slow down enemy infantry assaults. They also

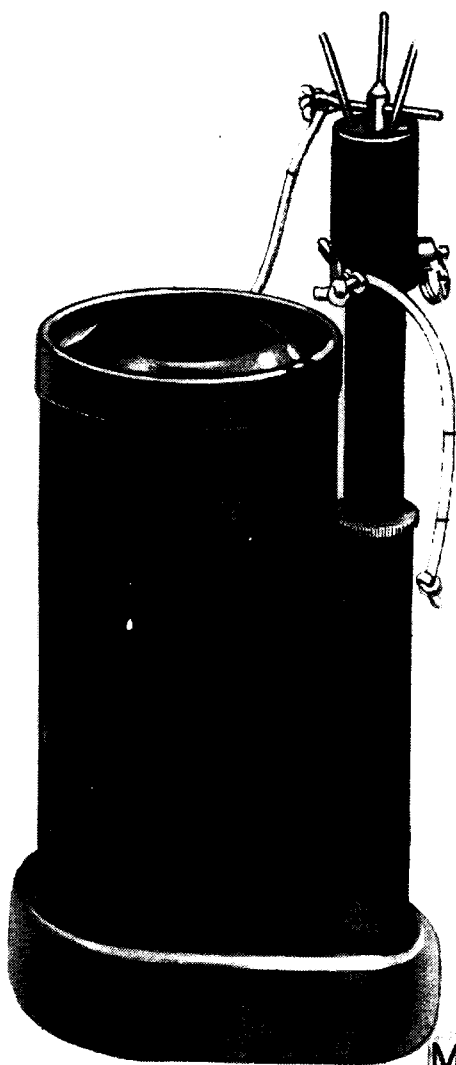


Fig. 137. The M2A3 and M3 antipersonnel mines.

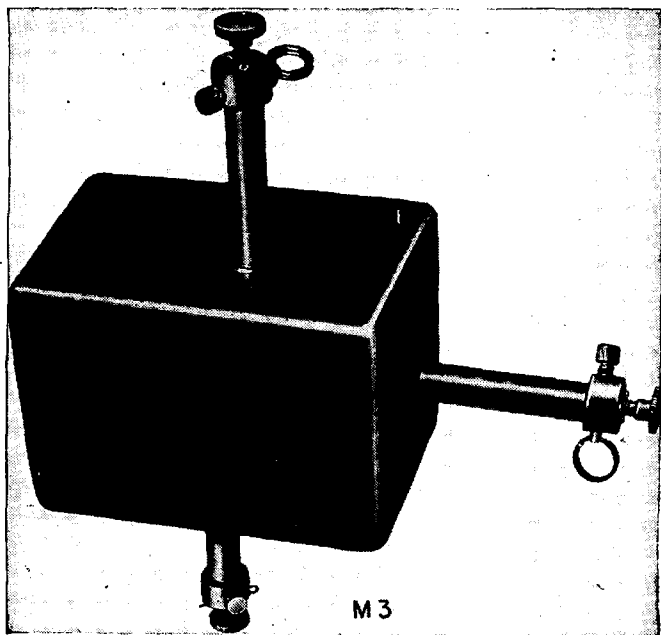


Figure 137. The M2A3 and M3 antipersonnel mines.—Continued.

are used with antitank mines to delay infantry-supported mechanized attack and to hinder the removal of the antitank mines, and as booby traps or in obstacles to further impede the enemy.

c. Antitank mines. Antitank mines (see fig. 138) are used to immobilize enemy armor and to slow up a mechanized attack so individual tanks can be knocked out by covering antitank fire.

d. Booby traps. A booby trap is a hidden charge with its firing mechanism placed so the trap will be set off by an unsuspecting person lifting or moving an ap-

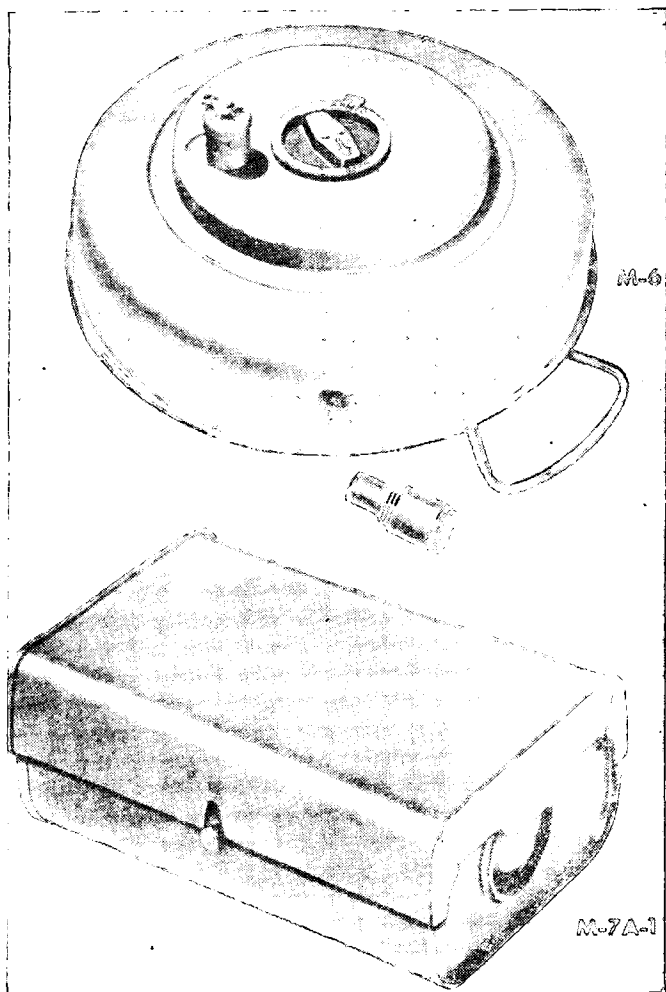


Figure 138. The M6 and M7A1 antitank mines.

parently harmless object. Booby traps were developed from mines. They are an effective harassing device but produce casualties to only a small percentage of troops.

114. TYPES OF MINE FIELDS. a. Mines laid for security of small units. Squad, platoon, and sometimes company-size units may lay antitank mines around a bridge site or other confined working or bivouac area to help protect the unit from possible enemy armor attack. These mines normally are laid unburied in no set pattern and are not recorded. They always are removed by the unit laying them upon completion of the task.

b. Unit mine fields.

- (1) *General.* Unit mine fields are installed by units below division level for local security of positions, usually of company, battalion, or regimental size. A unit mine field need not be authorized by the division commander. Unit mine fields contain only antitank mines laid unburied in a standard pattern and recorded. Trip flares often are included and take the place of antipersonnel mines. Antipersonnel mines are laid only on order of the division or higher commanders and always are recorded. Only engineers and specially trained troops lay antipersonnel mines.
- (2) *Responsibility.* The unit commander is responsible for liaison with adjacent units and for informing higher headquarters of unit mine fields laid by his unit. Close liaison between mine-laying units, headquarters, and adjoining units is imperative because it may be necessary in certain areas to—

- (a) Insure that the ground over which an attack is to be launched is kept clear.
- (b) Leave lanes through which friendly vehicles and personnel can move.
- (c) Economize on effort and material.

c. Divisional mine fields.

- (1) *General.* Divisional mine fields are installed to improve the antimechanized and antipersonnel defense of barrier systems of large units by channelizing the enemy's attack, and holding him in areas covered by intense defensive fires. Divisional mine fields are installed to fit a predetermined barrier plan; unit mine fields previously installed may be altered or enlarged to fit the plan and be incorporated in it.
- (2) *Responsibility.* The division or corps commander specifies the general location for the barrier system and the policy for the use of antipersonnel mines, activating devices, and booby traps. The division engineer decides the detailed siting of mine fields in close coordination with antitank, infantry, and artillery commanders concerned. The mission of installing divisional mine fields normally is assigned to engineer troops, but assistance from other arms may be required in order to lay mine fields in the allotted time.

d. Nuisance mine fields. During retrograde movements, and only when the situation requires drastic action, antitank and antipersonnel mines are scattered along avenues of approach to positions, turn-outs,

bivouac areas, and other likely positions to harass and slow the enemy, destroy his morale, and inflict as many casualties as possible. Mines are laid in this manner only in an extreme emergency and only on specific order of corps and army commanders. They are usually not covered by fire.

e. Dummy mine fields. To be effective, dummy mine fields must supplement live fields, must be marked and fenced in a manner similar to actual mine fields, and must be sited so direct fire from covering weapons may protect them against enemy reconnaissance and breaching parties.

115. MINE-FIELD REQUIREMENTS. A mine field should—

- a.** Be covered by fire.
- b.** Be under friendly observation.
- c.** Be completely wired in, marked, and recorded.
- d.** Avoid regular geometric lay-outs and easily disclosed positions.
- e.** Be concealed from hostile ground and air observation.
- f.** Be anchored with natural obstacles whenever possible and arranged so it cannot be bypassed or outflanked.
- g.** Be coordinated with other elements of defense.
- h.** Have a mine density sufficient to stop a tank going through the field at any angle.
- i.** Have lanes for friendly patrols and vehicles.

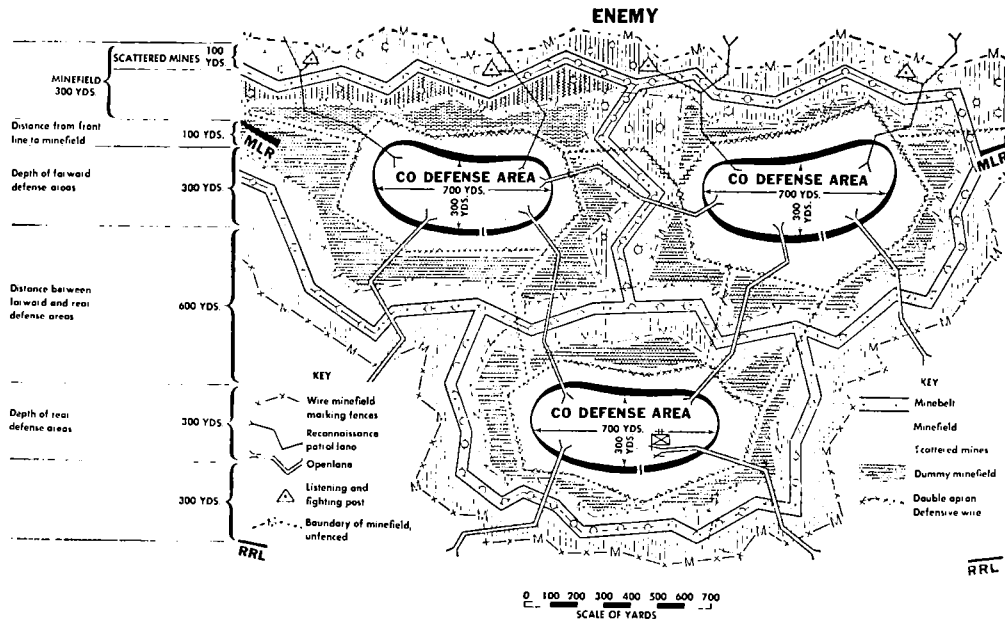


Figure 139. Lanes through mine fields in a battalion defense area.

116. LANES THROUGH MINE FIELDS. Lanes or paths are provided through mined areas to permit the passage of friendly patrols (see fig. 139). These lanes must be marked clearly, and in such a way that their location is not revealed to the enemy. Positions of lanes must be changed frequently so obvious tracks do not appear. Lanes may be marked with single-strand wire placed close to the ground on both sides of the path. Signs are posted to guide troops to the lanes. Lanes should be covered by fire to prevent their use by the enemy.

117. ACTIVATING MINES. The employment of activating devices varies with the policy of the army or corps commander and the type of field being installed. Unit mine fields installed for warning purposes do not require activating devices. However, divisional mine fields as part of a barrier plan require them. The number of activated mines laid in a mine field is determined by the unit commander, according to the policy of the corps or army commander.

118. MINE-FIELD LAYING REQUIREMENTS. The general requirements for laying mine fields are as follows:

a. Mines are laid so neither the over-all pattern nor the individual mines are apparent to the enemy, even after he has entered the field.

b. The pattern and laying drill must be simple so mines may be laid quickly and recorded easily even at night or in inclement weather.

c. The lay-out should be standard within each belt, yet flexible enough to meet variations in terrain.

d. Clear lanes should be kept to a minimum.

e. Units laying mine fields must be organized into details and assigned specific tasks to do the job quickly and efficiently and with the least amount of confusion. A recommended organization is given in FM 5-31.

f. Each mine field is installed in four stages—siting, laying, marking, and recording.

119. MINE-FIELD SITING. a. **Importance.** Correct siting of a mine field is of utmost importance because it fixes the location of supporting weapons and greatly affects future operations.

b. **Basic principles.** Close liaison and coordination is necessary between the unit laying the field and the unit protecting it. Each field must be laid in terrain which can be covered effectively by supporting small-arms, antitank-gun, and artillery fire.

c. **Utilization of terrain.** Mine fields have little or no tactical value if they can be bypassed or outflanked; therefore, they should be anchored to natural obstacles as is any other artificial obstacle. Proper employment and siting of mine fields with natural obstacles reduces the necessary protective covering fire. The effectiveness of a mine field is increased by laying it on terrain which cannot be observed or is difficult to observe by the enemy. See FM 5-31 for full information on mine-field siting.

120. ESTIMATING MATERIALS AND LABOR. Standard mine belt patterns and drills for laying have been developed and adapted to simplify laying, recording, and estimation of time and materials needed. Mine belt patterns are described in chapter 3, FM 5-31. The pre-

scribed density found best is approximately one and one-half mines per yard of front. Time consumed for laying varies greatly under field conditions. Table X indicates the average number of yards per hour which can be laid by various sized groups under normal conditions.

TABLE X. Average Time-Distance Factors for Laying an Antitank Mine Belt

Size of work detail	At mine belt w/o antipersonnel mines	At mine belt with antipersonnel mines
1 platoon	200 yds. per hour....	100 yds. per hour
1 squad	50 yds. per hour....	30 yds. per hour
1 man	5 mines per hour...	4 mines per hour

121. INSTALLING MINES. Mines may be buried or laid on the surface of the ground, depending on the time available and the amount of concealment necessary. If ordered by division or higher headquarters, antipersonnel mines and activating devices are installed. These are all accurately located and recorded. A mine belt may be laid in three phases:

- a. Mines are laid on ground; the field is marked and recorded.
- b. Mines are buried.
- c. If ordered by division or higher headquarters, antipersonnel mines and activating devices are installed.

122. MARKING AND RECORDING MINE FIELDS.

a. Marking. To prevent casualties among friendly troops, all mine fields, including dummy fields and enemy fields

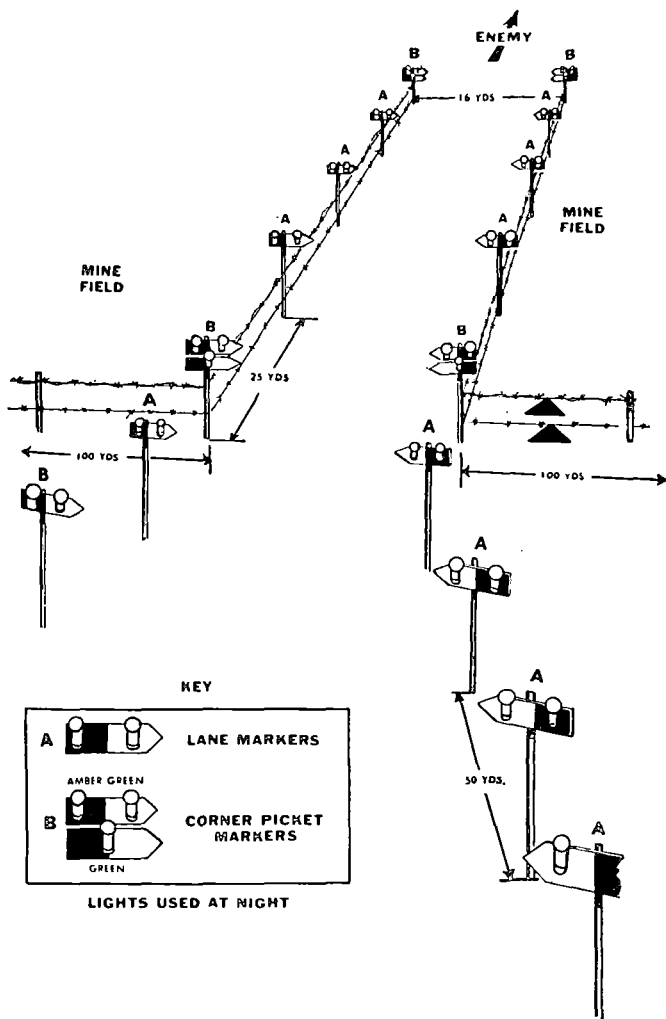


Figure 140. Mine-field marking and fence.

which have been overrun and incorporated within the defense plan, must be clearly marked. Steps also must be taken to prevent friendly troops from entering fields being laid and marked. This is a responsibility of the unit laying the field. Fences must be strong enough so they will not collapse and leave the field unmarked. Breaks should be repaired immediately. Fences always are completed even if the field is not finished. However, they never are allowed to indicate the actual shape of the field; extra fencing may be installed for deception. Lanes left in fields to allow friendly patrols and vehicles to pass must be marked by a fence. (See fig. 140)

b. Recording. As soon as the officer in charge of laying the mine field has organized and started the work, he sends the following information to division or corps headquarters:

- (1) Location and area of the field.
- (2) Estimated time of completion.

A separate party fills out the location report form and prepares a detailed record of the field while each belt is being laid. The pattern laid must be clearly indicated on the record. The complete record consists of the detailed record of the actual mine pattern, a map and photograph supplement to the detailed record, and the location report. Chapter 3, FM 5-31 describes in detail the preparation and processing of mine-field records.

123. DEFENSE OF THE FIELD. a. Supporting fire. All antitank fields except nuisance mine fields must be covered by small-arms and antitank gun fire. Mine fields and obstacle sites prepared for demolition should be

registered in by several artillery batteries from separate artillery battalions. Liaison with the artillery is of utmost importance when necessary to call for fire from all supporting weapons at one obstacle site or mine belt. Supporting weapons must be called when the enemy attempts to breach mine fields by driving tanks through them ahead of infantry. Having the field previously zeroed results in a saving of time and lives, and quick disorganization of the attacking force. A mine field not properly covered by effective fire from all weapons will not delay the enemy enough to warrant the labor and materials expended and possible casualties to friendly personnel during laying of the field.

b. Defense posts. Defense posts may be placed in front of the mine field or barrier or within the mine field itself to prevent the enemy from making thorough reconnaissance or removing portions of the field.

c. Defense of forward units. One method of employing mines for the defense of forward units is called the cellular or honeycomb method. Its use tends to guide enemy attacks into pockets and delay them in an area surrounded by mines. Concentrated or massed fire may be brought to bear on the attacking force to break up its organization and leave it vulnerable to a coordinated counterattack through known lanes.

CHAPTER 6

BARBED-WIRE OBSTACLES

Section I. INTRODUCTION

124. EMPLOYMENT. a. **General.** Barbed wire obstacles are designed to impede the movement of foot troops and horse cavalry, and to slow up or stop wheeled or tracked vehicles.

b. **Mission.** Entanglements are classified by mission as tactical, protective, or supplementary.

- (1) *Tactical* wire entanglements are sited along the friendly side of the final protective line to break up enemy attack formations and hold the enemy in areas covered by the most intense defensive fire. Tactical entanglements extend across the entire front of a position but are not necessarily continuous. (See fig. 141.)
- (2) *Protective* wire entanglements are located to prevent surprise assaults from points close to the defense area. They are close enough to the defense area for day and night observation and far enough away to keep the enemy beyond normal hand-grenade range. Depending on terrain, 30 to 100 yards fulfills these requirements. Protective wire surrounding company areas may be connected to inclose an entire battalion defense area. Protective wire



Figure 141. Tactical wire entanglements in front of a trench.

entanglements are erected around rear-area installations in the same manner and to serve the same purpose as protective wire around defensive positions in forward areas.

- (3) A skillfully sited entanglement can perform both tactical and protective missions.
- (4) When time permits, *supplementary* wire entanglements are added to conceal from the enemy the exact line of the tactical wire and the direction of the final protective line. Sup-

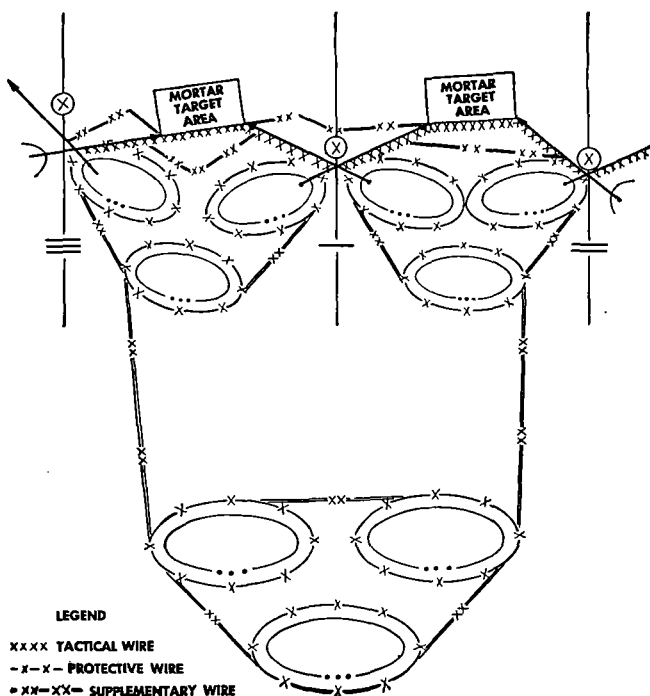


Figure 142. Wire entanglements in battalion defense area.

plementary wire is used also to connect platoon and company defense areas.

- (5) Figure 142 shows typical use of wire in a battalion defense area.
- (6) Barbed-wire obstacles are used primarily in the perimeter defense to restrict infiltration. This necessitates a liberal use of warning devices. Entanglements about such a position are located to serve both a tactical and protective mission and are sited to be covered by fire from the automatic weapons of the defending unit.
- (7) Time and material permitting, the minimum requirement for tactical wire is an entanglement equivalent in density to one belt of double-apron fence. Protective wire may be of any type entanglement; however, it usually is of a type equivalent in density to the four-strand fence. To fulfill its mission, supplementary wire should be equivalent in density to that type wire it supplements.

c. Depth. Entanglements are classified by depth as belts, bands, or zones.

- (1) Belt: single line of wire entanglement.
- (2) Band: two or more belts in depth, with no interval between them.
- (3) Zone: several bands or belts in depth, with intervals between them.

d. Fixed or portable. Wire obstacles may be fixed or portable.

- (1) Fixed obstacles are erected in position and cannot be moved unless disassembled.
- (2) Portable obstacles can be prepared in rear areas and transported and installed in final positions. They may be used for closing gaps in fixed entanglements.

e. Winter use of wire obstacles.

- (1) The installation of wire obstacles in winter is made difficult by frozen ground and snow, which make it necessary to build obstacles considerably higher than usual (up to 13 feet). If frozen ground must be blasted for the stakes, holes for the charges are made with strong pickaxes or red-hot iron rods. The narrow holes then are enlarged by means of blasting cartridges or other explosive charges until heavy stakes up to a length of 13 feet may be placed in them. Water is poured around the stakes in order to freeze them firmly.
- (2) One disadvantage in building wire entanglements on snow is that the enemy is able to crawl under them. For this reason, alarm devices, such as cans filled with nails, must be affixed to the wires at various heights. The effectiveness of such devices must be tested frequently.

125. REQUIREMENTS. A wire entanglement should—

- a. Be covered by fire.

b. Be under observation and be protected by anti-personnel mines and warning devices.

c. Avoid regular geometric lay-outs and easily disclosed positions.

d. Be concealed from ground and air observation wherever possible by incorporation of natural features such as hedges, woods, paths, or fence lines.

e. Be coordinated with other elements of the defense. (See FM 100-5 for organization of the ground.)

f. Be used in sufficient quantity. Generally, the more wire used, the more effective the entanglement. Zones of entanglements should be erected whenever possible.

126. GAPS. a. Function. Gaps are left in the wire to—

(1) Provide passage for patrols or working parties.

(2) Permit advance of friendly attacking or counterattacking elements.

b. Location. Gaps are coordinated with the antipersonnel mines in and around the obstacles so as not to endanger friendly troops. There should be enough gaps to permit their alternate use, thus lessening the danger of creating conspicuous paths. In zones or deep bands of entanglements, gaps are echeloned to provide zigzag paths. When not in use, gaps are blocked by portable obstacles or protected by fire.

c. For an advance. Gaps for assault elements in an advance are cut before the assault starts. Machine-gun fire and outposts protect the gaps.

Section II. PREPARATION OF BARBED WIRE FOR USE

127. STANDARD BARBED WIRE. **a. Description.** Standard barbed wire is twisted, double-strand, No. 12 wire (A. S. and W. gage), with four-point barbs spaced about 4 inches apart (fig. 143).

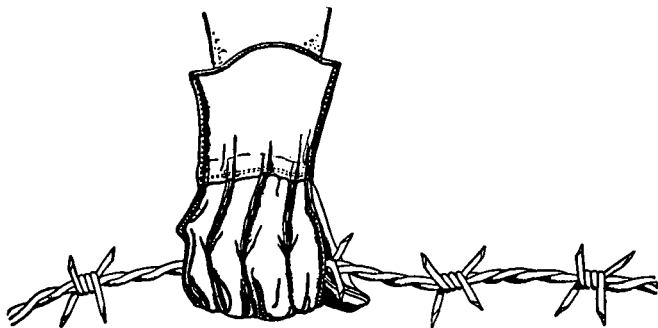


Figure 143. Standard barbed wire.

b. Gloves. When working with barbed wire, barbed-wire gauntlets or heavy leather gloves should be worn for faster work and to avoid cuts and scratches. The wire should be grasped with palms down as an added safety precaution.

c. Reels. Barbed wire normally is issued in reels (fig. 144) containing about 400 yards of wire; the wire weighs 100 pounds and the reel 5 pounds. In building a fence, two men handle one reel. Reels are handled as follows:

- (1) Attach end of wire to first anchor picket.
- (2) Insert bar in reel and carry reel 25 or 30 yards, unreeling wire from bottom of reel.

- (3) Walk back a short distance toward starting point, turn reel around, and set it down. This leaves slack with which to start work. To get more slack, unroll reel by pulling on wire.
- (4) Return to starting point and install wire; men leapfrog each other to make ties. If available, two extra men can be assigned to make ties while the reel is unwound.

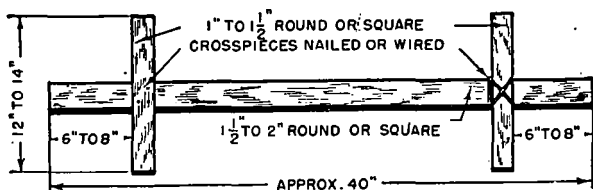


Figure 144. Barbed-wire reel.

d. Bobbins. Bobbins are used to build short lengths of fence, to repair obstacles, and for training. They normally are prepared in the rear. Two men handle one bobbin in erecting a fence; one unwinds the bobbin

while the other installs the wire. Two or more men make a bobbin as follows:

- (1) Prepare bobbin stick.
- (2) Set reel on improvised trestle.
- (3) One man unreels and cuts 30-yard lengths of wire and fastens one end to the trestle.
- (4) Others wind wire in figure eights on bobbin stick. (See fig. 145.)



FREE END MARKED WITH WHITE TAPE

Figure 145. Making a bobbin.

128. STANDARD BARBED-WIRE CONCERTINA.

a. Description. The standard barbed-wire concertina (fig. 146) is a commercially manufactured wire-roll obstacle made of a coil of high-strength steel barbed wire clipped together at intervals to form a cylinder weighing 55 pounds. Opened, it is 50 feet long and 3 feet in diameter; it collapses to a roll 6 inches thick and 3 feet 4 inches in diameter. It is easily opened and col-

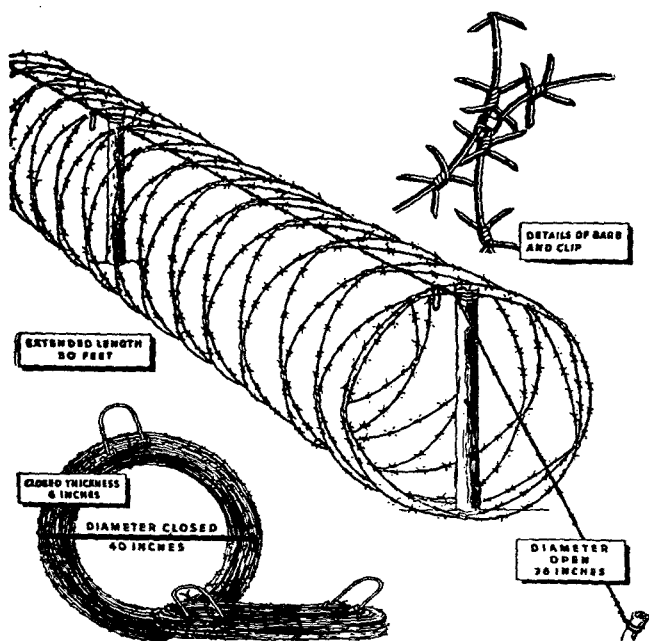


Figure 146. Standard barbed-wire concertina.

lapsed, and can be used repeatedly because its elasticity is such that it returns almost to its original shape when a crushing force is applied and then removed. It is harder to cut than standard barbed wire.

b. To open concertina. Four men open a roll. One man works at each end; others space themselves along the coil to make certain it opens evenly.

Caution: The collapsed roll is tied with plain-wire bindings fixed to the quarter points of an end coil. These bindings must not be cut or removed when the

roll is opened, as they are needed for retying the concertina when it is again collapsed.

c. To collapse concertina. Two men collapse a concertina as follows:

- (1) Remove all kinks in coil. Tighten loose clips or replace with plain wire.
- (2) Close coil, lay it flat, and compress with feet.
- (3) Tie with plain-wire bindings.

d. To carry concertina. One man easily can carry a roll by stepping into it and picking it up by the wire handles attached to the midpoints of an end coil.

129. PICKETS. Metal or wooden pickets are used to support wire entanglements.

a. Metal pickets. Metal pickets are issued in standard lengths, short or anchor, medium, and long. There are two types of metal pickets, screw and U-shaped. (See fig. 147.) The U-shaped picket also is issued in an extra-long size. U-shaped pickets have a hole in the end for ease in bundling.

b. Wooden pickets. Dimension lumber or cut natural timber can be used for wooden pickets. However, when wooden pickets are used, it is better to secure small trees of the required diameter and use without peeling the bark (fig. 147.) The light-colored wood of pickets split from large trees or dimension lumber may give away the location of the entanglement. Anchor pickets are $1\frac{1}{2}$ to $2\frac{1}{2}$ feet long and 2 to 3 inches in diameter. Long pickets are 5 to 6 feet long and 3 to 4 inches in diameter. Longer pickets are required in loose or sandy soil. In deep snow, pickets should be erected with broad

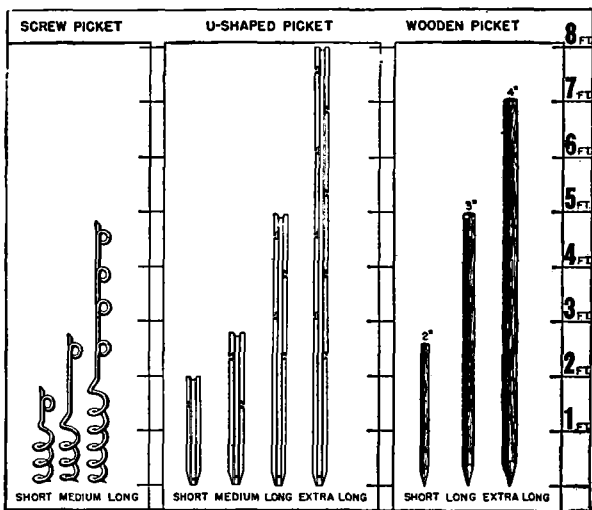


Figure 147. Barbed-wire pickets.

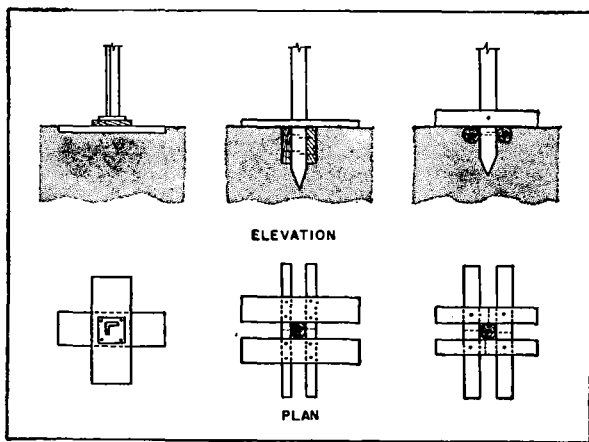
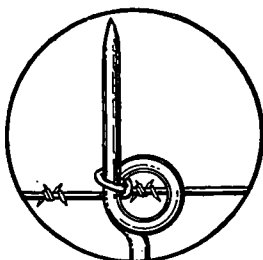


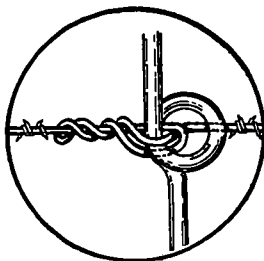
Figure 148. Barbed-wire pickets in snow.

bases. Logs or squared timber and plank, about 6 feet long, are used to make the pole and base (fig. 148). When obstacles of this sort are erected in several rows, wooden rods may be placed between them as braces. (*Do not obstruct fields of fire!*)

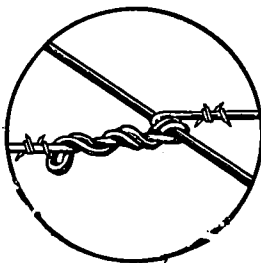
130. WIRE TIES. Four ties are used in erecting wire entanglements. (See fig. 149.)



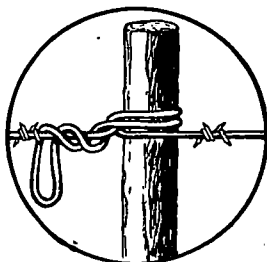
TOP-EYE TIE



INTERMEDIATE-EYE TIE



APRON TIE



POST TIE

Figure 149. Ties used in erecting wire entanglements.

a. Top-eye tie. The top-eye tie is used to fasten wire to the top eye of screw pickets. It is made with one continuous movement as shown in figure 150.

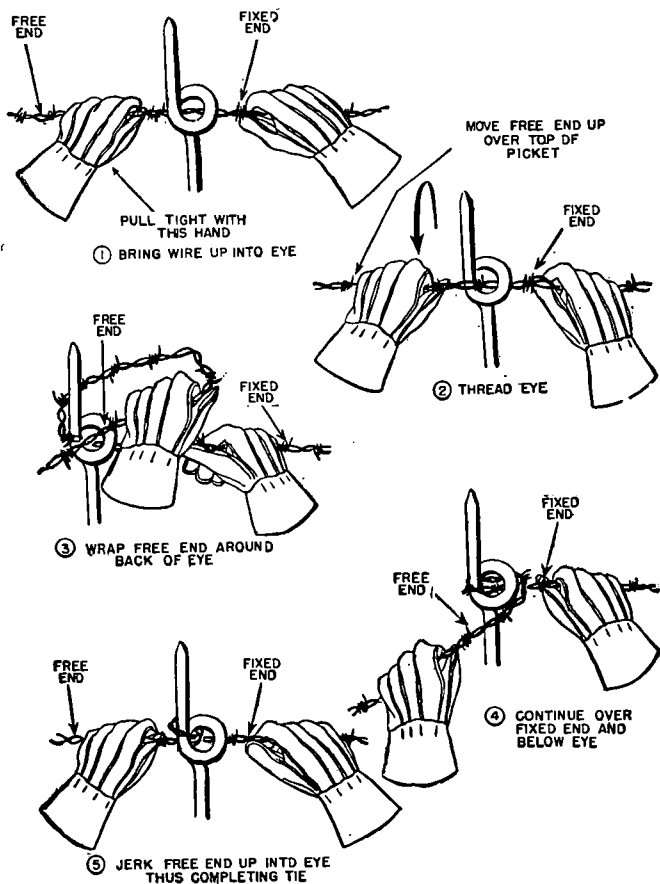


Figure 150. Top-eye tie.

b. Intermediate-eye tie. The intermediate- or split-eye tie (fig. 151) is used to fasten wire to all but the top eyes of screw pickets. Keep in mind the following rules:

- (1) Reach around picket and over fixed wire, keeping palm down.
- (2) Take loop from free end. Wrap it around fixed end.
- (3) Make certain one side of loop passes above eye and other side below eye.

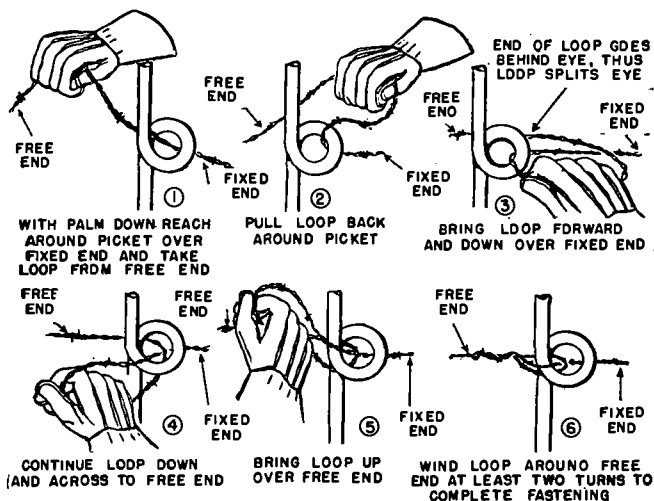


Figure 151. Intermediate-eye tie.

c. Apron tie. The apron tie is used in the double-apron fence to fasten the apron wires to the diagonal wire. Figure 152 demonstrates how it is made.

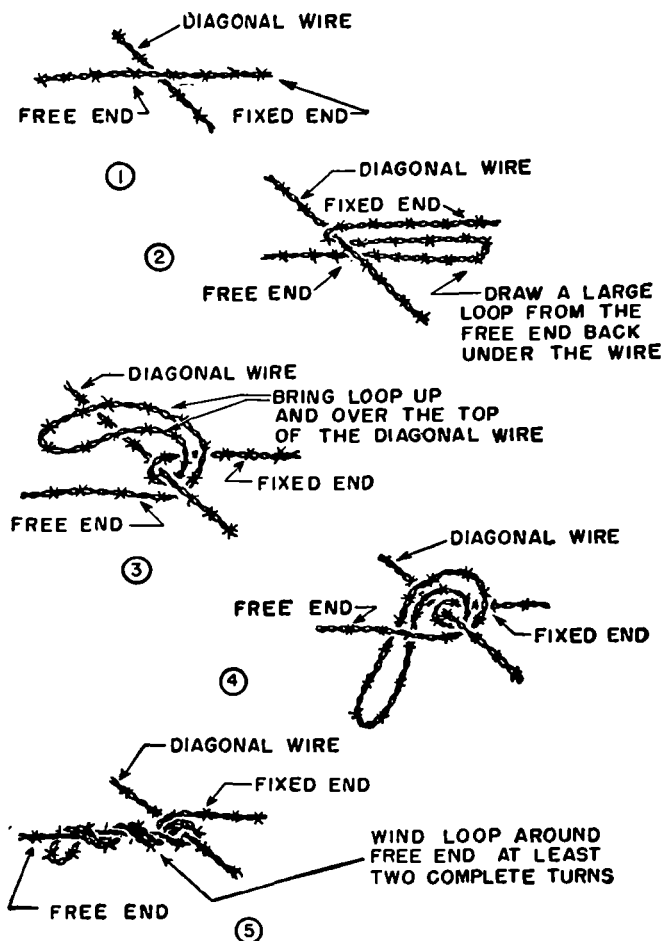
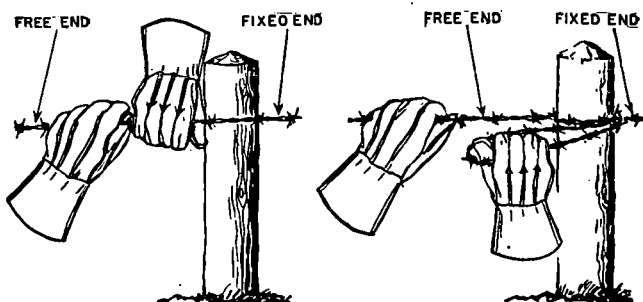


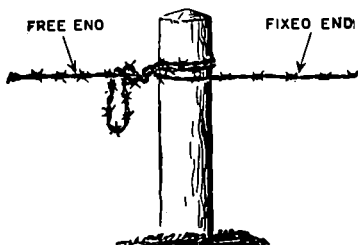
Figure 152. Apron tie.

d. **Post tie.** Wire is fastened to wooden posts or steel U-shaped pickets with the post tie shown in figure 153. The wire must be wrapped tightly around the post. When U-shaped pickets are used, the free end of the wire is put into the notch before the tie is made.



① WITH PALM DOWN REACH AROUND PICKET OR POST OVER FIXED END AND TAKE LOOP FROM FREE END

② WRAP LOOP AROUND POST ABOVE FIXED END



③ WRAP LOOP AROUND FREE END AT LEAST TWO TURNS TO COMPLETE TIE

Figure 153. Post tie.

Section III. TYPES OF WIRE ENTANGLEMENTS

131. GENERAL. Standardized procedures aid in erecting wire entanglements, but must be adapted to fit field conditions. Work crews must be organized so construction proceeds in proper order and at a uniform rate. Men are selected for the job they do best, with the fastest men leading each phase of the work. Each individual must know exactly *what* his group is to do and *how* it is to do it. Each man should have special barbed-wire gauntlets. For best results, fences should be built in increments of 100 yards or less when using bobbins, and 300 yards or less when using reels. Table XI is only a guide; unusual conditions may require some changes. However, in all cases the sequence of tasks should be followed. *All fences are built from right to left as one faces the enemy.* Double apron fence and similar difficult-to-construct wire obstacles are being superseded by the concertina types. The later are far more flexible, require less work to install, lend themselves more readily to difficult terrain, and are more effective against high-speed mechanized vehicles.

132. DOUBLE-APRON FENCE. a. General. There are two types of double-apron fence—the 4- and 2-pace fence and the 6- and 3-pace fence. The 4- and 2-pace fence (fig. 154) is a better obstacle and is more commonly used. In this fence, the center pickets are 4 paces apart and the anchor pickets are 2 paces from the line of center pickets and opposite the midpoint of the space between center pickets. The 6- to 3-pace fence follow the same pattern with pickets at 6- and 3-pace intervals. There are two operations in building a double-apron

fence: laying out and installing pickets, and installing wire. Table XI shows working parties and tasks for erecting a double-apron fence.

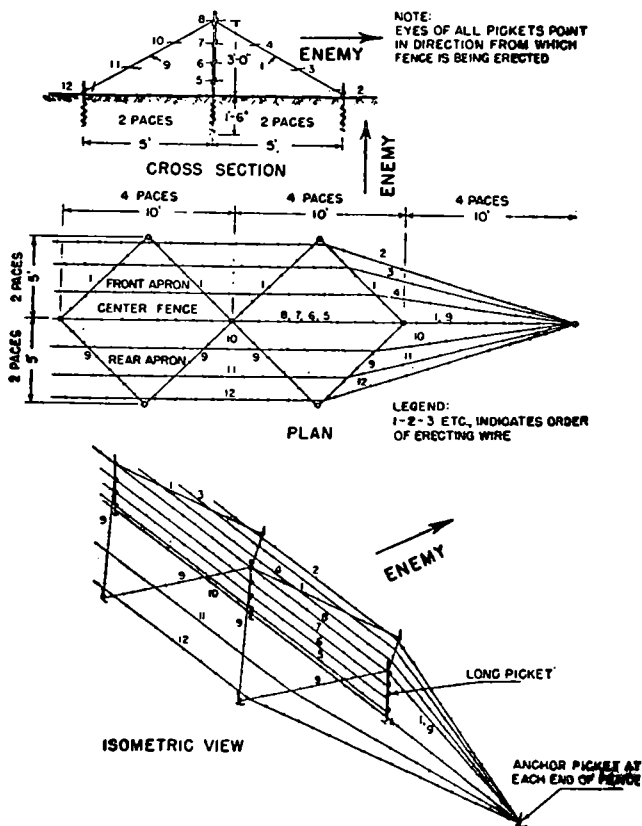


Figure 154. Double-apron fence.

TABLE XI. Erection of 4- and 2-Pace Double-Apron Fence (Fig. 154)

WORKING PARTY

Varies from squad leader plus 7 to 11 men for short lengths of fence to full platoon for 300-yard fence. Crew of about one squad per 100 yards of fence gives best results.

OUTLINE OF WORK

Crew	First task	Second task
One-third of working party.	Lays cut long pickets. First man paces off 4 paces between long pickets. He lays first picket at head of work; balance of group follow and place rest of long pickets.	As first task is completed, men move individually to head of work and form teams to install wires. First team installs front diagonal wire and succeeding teams install next wire in order. Men work in teams of 2 or 4 depending on number available. When 4 men work on one team, 2 carry the reel and 2 make the ties.
One-third of working party.	Lays out anchor pickets, including end anchor pickets.	
One-third of working party.	Installs pickets. One-half installs front-apron anchor pickets; other half installs long pickets. When these are in, all install rear-apron anchor pickets.	
Senior NCO	General supervision.	

b. First operation

(1) *Working party.* The working party may vary from 7 to 11 men (approximately a squad) for each 100 yards of fence. A platoon is an adequate working party when constructing a 300-yard section. Divide the working party into three groups for the first operation and assign the following tasks: laying out long pickets, laying out anchor pickets, installing all pickets.

(2) *Lay-out cut pickets.*

- (a) Determine line of fence and lay out long pickets at 4-pace intervals (10 feet) with points on center line.
- (b) Place anchor pickets at each end of center line, 4 paces from adjoining long pickets.
- (c) Lay out anchor pickets with points 2 paces from center line and midway between long pickets (fig. 155).
- (d) Place all pickets with points toward enemy.

(3) *Installing pickets.*

- (a) Install pickets at spot where points lie, making necessary minor adjustments to keep fence line straight.

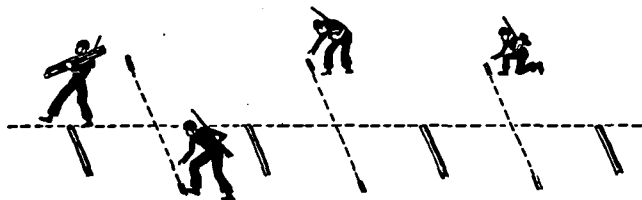


Figure 155. Laying out anchor pickets.

- (b) First install long pickets and front anchor pickets, then rear anchor pickets.
- (c) Install screw-pickets with eyes pointing to head of the work (starting point). If possible, twist entire screw portion into ground with a bar inserted in bottom eye. *Only* bottom eye is used to avoid bending picket.
- (d) Drive U-shaped pickets with hollow surface toward enemy.
- (e) Install short driven pickets at right angles to diagonal wire.
- (f) To drive pickets at night when silence is essential, use a maul with rubber head improvised from salvaged tires.

c. Second operation (installing wire)

- (1) After completing task of first operation, all men of the working party install wires. Follow sequence given in figure 156.
- (2) Stretch tightly all wires, especially the center fence wires. This makes it harder to crush the fence.
- (3) Fasten diagonal wires (Nos. 1 and 9) to anchor and long pickets.
- (4) Fasten trip wires (Nos. 2 and 12) to one or both diagonal wires. The friendly trip wire (No. 12) may be fastened to eye of anchor picket. Trip wires must be tight and from 2 to 6 inches off ground.
- (5) Fasten other apron wires (Nos. 3, 4, 10, and 11) to every second diagonal wire; alternate so each diagonal wire has at least one apron

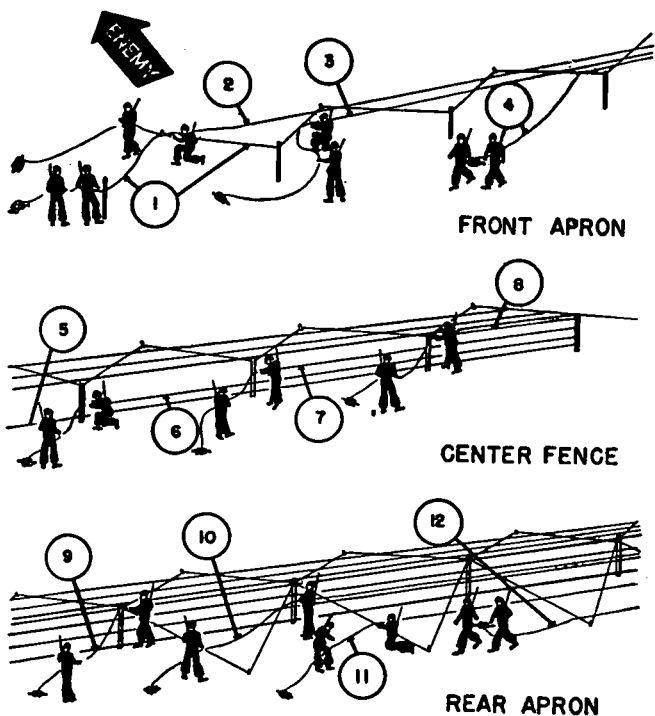


Figure 156. Sequence of installing wire in a double-apron fence.

wire attached to it. Tie all apron wires to first and last diagonal.

- (6) Start and finish diagonal and apron wires at end anchor pickets. Start and finish fence wires at end long pickets.
- (7) Men installing wire face enemy, work on friendly side of fence, and work from right to left.

133. TRESTLE APRON FENCE. Figure 157 shows one type of barbed-wire fence which may be used in snow or frozen ground. In building the fence, the trestle supports are laid out on the ground. After the horizontal strands of barbed wire have been fastened to the trestles, the latter are raised and held in position by the base tension wire.

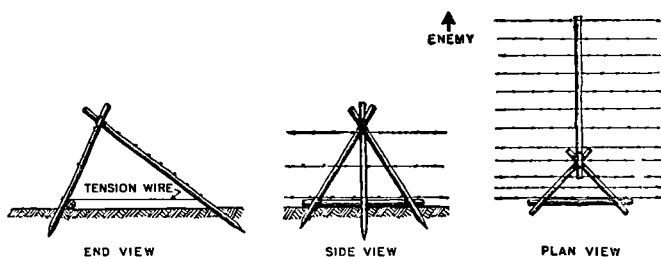


Figure 157. Trestle barbed-wire fence.

134. LAPLAND FENCE. Figure 158 shows the Lapland fence which can be used equally well on frozen or rocky ground and on bogs or marshland. This fence is wired with six strands of barbed wire on the enemy side, four strands on the friendly side, and four strands on the base. In snow, the tripods can be lifted out of the snow with poles or other means to reset the obstacle on top of newly fallen snow. On soft ground, the base strutting of tripods and the base wires give enough bearing surface to prevent the obstacle from sinking.

135. CONCERTINAS. The concertina is a portable obstacle manufactured commercially (standard concertina) or constructed in the field. It is used to erect three types of fence and is rapidly replacing other types of

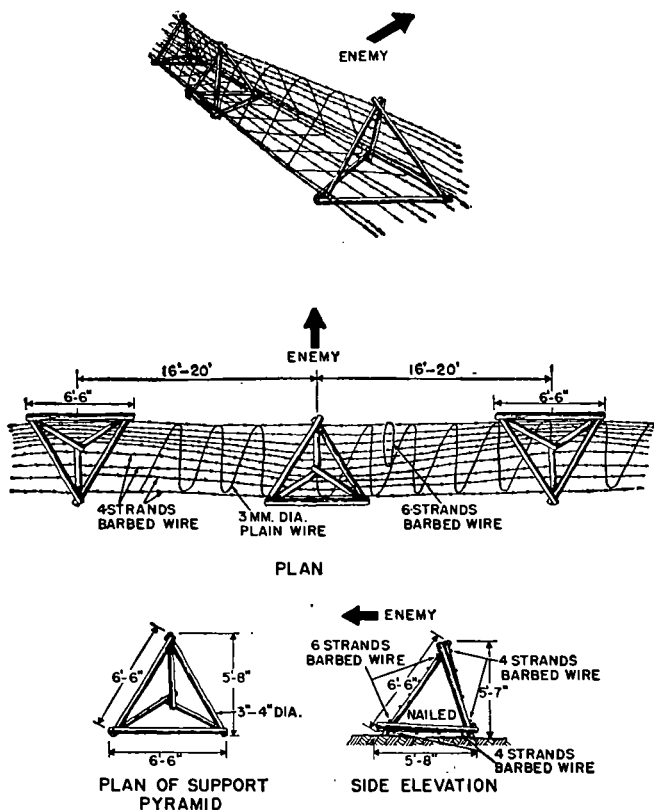


Figure 158. Lapland barbed-wire fence.

fence obstacles. In deep snow, concertinas are particularly effective.

a. Single Concertina. This is one line of concertinas. It is erected quickly and easily, requires a minimum of materials, but is a poor obstacle when used alone. It is used as an emergency entanglement or to fill gaps be-

tween other obstacles. A single concertina fence may be installed without pickets if its ends are racked together. One section of concertina (50-foot length) may be carried on the bumper of each organization vehicle in engineer units so it will always be available when needed by engineer working parties.

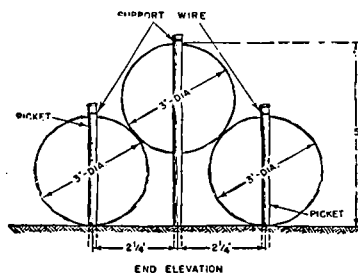
b. Double concertina. This consists of a double line of concertinas with no interval between lines and staggered joints. It is less effective than a well-emplaced double-apron fence. It is used to supplement other entanglements in a band. Double concertina is laid as shown in figure 135.

c. Triple concertina (pyramided). This consists of two lines of concertinas serving as a base with the third line resting on top with joints staggered. Each line is completed before the next is started, so even a partially completed entanglements presents some obstruction. It is erected quickly, and is difficult to cross, cut, or crawl through. It is used as a continuous obstacle. (See fig. 159.)

136. TRIPLE STANDARD-CONCERTINA FENCE. A triple concertina fence is the type most often constructed. It is built in two operations.

a. First operation. Divide the working party into three groups for the first operation and assign the following tasks: laying out all pickets, installing all pickets, laying out concertinas.

- (1) Determine line of fence and set front-row long pickets 5 paces apart on this line (fig. 160). Place rear row pickets 3 feet behind and op-



OR

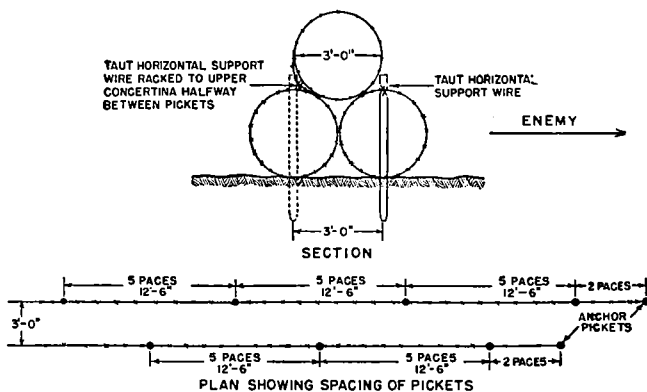


Figure 159. Triple concertina.

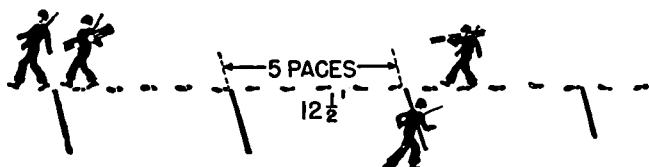


Figure 160. Laying out long pickets for triple concertina fence.

posite center of interval between front-row pickets.

- (2) Set out anchor pickets at the start and finish of each row, 2 paces from adjoining long picket.
- (3) Install front-row pickets first (fig. 161). Eyes of screw pickets point to head of work; hollow surfaces of U-shaped pickets face enemy.

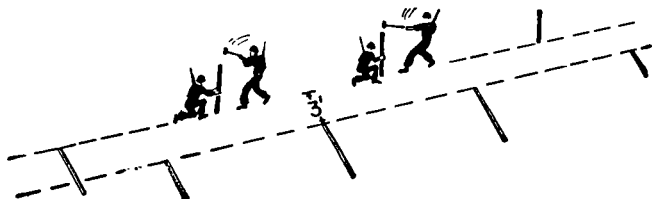


Figure 161. Installing front-row pickets for triple concertina fence.

- (4) Place concertinas along rows of pickets (fig. 162). One is placed by the third picket and every fourth picket thereafter in the front row, and two by the third picket and every fourth picket thereafter in the rear row. The extra concertina is used to form the top row.
- (5) Unfasten binding wires as concertinas are placed along rows of pickets.

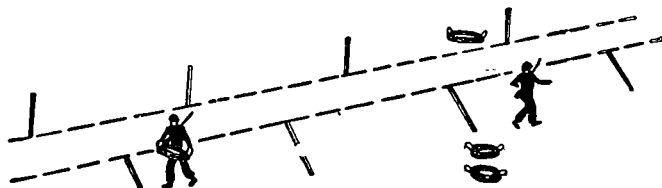


Figure 162. Placing concertinas along rows of pickets.

b. Second operation.

- (1) After completing the first operation, all men of the working party install concertinas and horizontal wires. Follow sequence given in figure 163.

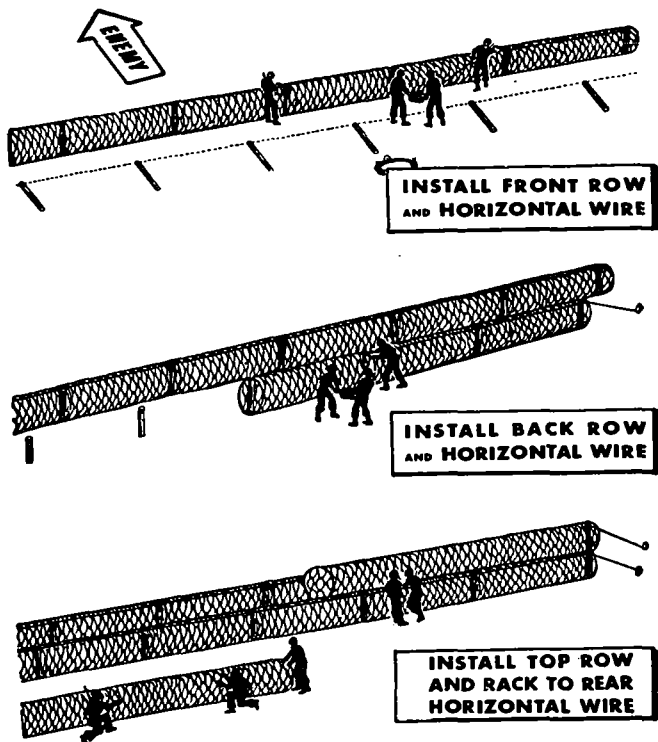
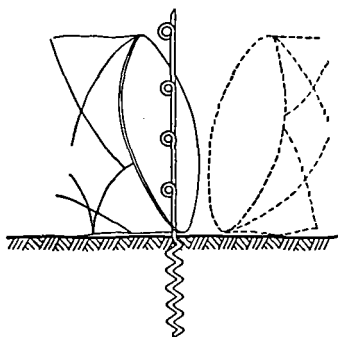
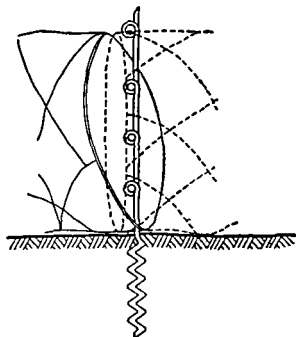


Figure 163. Installing concertinas.

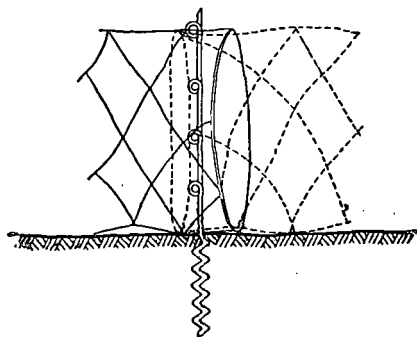
- (2) Open the front-row concertinas in front of the line of pickets and the rear- and top-row concertinas in the rear of the line. Lift each concertina, and drop it on the pickets; then join concertinas as shown in figure 164, staggering joints.



① PLACE BOTTOM PORTION OF FIRST COIL OVER PICKET



② PLACE BOTH BOTTOM AND TOP PORTION OF SECOND COIL OVER PICKET



③ PLACE TOP PORTION OF FIRST COIL OVER PICKET

Figure 164. Joining concertinas

- (3) Stretch barbed-wire strand along tops of lower rows and fasten to pickets. Wire must be tight to make it more difficult to crush obstacle. Rack top concertinas to rear horizontal wire at a point halfway between pickets. This is a minimum racking. See table XII for erection of the triple standard-concertina fence.

137. FOUR-STRAND FENCE. The four-strand center section of a double-apron fence can be used as a simple entanglement if there is a shortage of time, men, or materials. Later, aprons can be added to develop it into a double-apron fence. To construct the four-strand fence (fig. 165), lay out pickets in the same manner as for the center fence of a double-apron fence. Start and finish all wires at anchor pickets. See table XIII for erection of the four-strand fence.

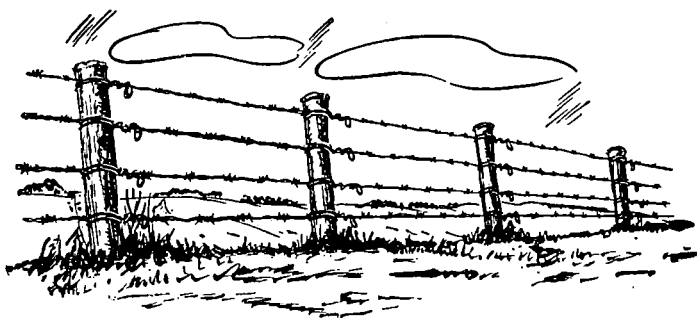


Figure 165. Four-strand fence.

TABLE XII. Erection of Triple Standard Concertina Fence

WORKING PARTY

Varies from squad leader plus 8 to 11 men for short lengths of fence to full platoon for 300-yard fence
Crew of about one squad per 100 yards of fence gives best results.

OUTLINE OF WORK

Crew	First task	Second Task
One-third of working party.	Lays out pickets, front row first. First man places head anchor picket 2 paces from first long picket and steps off 5-pace intervals for long pickets. End anchor picket is carried out with last lead and placed 2 paces from last long picket.	Opens and installs concertinas, front row first. As soon as first concertina is installed in front row, two men start pushing in front horizontal wire. Follows same procedure in rear row. When first concertina of top row is installed, two men start racking top row concertinas to rear horizontal wire.
One-third of working party.	Erects front row pickets. Returns to head of work and erects rear row pickets.	
One-third of working party.	Places concertina rolls in front row in front of third picket and every fourth picket thereafter. Returns to head of rear row and places two rolls behind each of same numbered pickets as in front row. Unfastens all binding wires as concertinas are placed on ground.	
Senior NCO.....	Assigns tasks as work progresses to insure that all phases of work proceed at proper rate.	

TABLE XIII. Erection of a Four-Strand Fence

WORKING PARTY

Varies from squad leader plus seven men for short lengths of fence to two squads for 300-yard fence. Crew of about seven men per 100 yards of fence gives best results.

OUTLINE OF WORK

Crew	First task	Second task
One-half of working party	Lays out long pickets. First man paces 4-pace interval between pickets and also lays head anchor picket and first long picket. Last man places end anchor picket.	As first task is completed, men move individually to head of work and start installing wires. First team installs bottom fence wire, and succeeding teams install next wires in order. Men work in teams of 2 or 4, depending on number available.
One-half of working party.	Installs pickets.	When men work on one team, 2 men carry the reel and 2 men make ties.
Senior NCO	General supervision.	

138. LOW-WIRE ENTANGLEMENT. a. Description. The low-wire entanglement (fig. 166) is built in the same manner as the double-apron fence, except for the center fence which has only one or two wires and medium instead of long pickets. For erection, use the drill as outlined for the double-apron fence. (See table XI.)

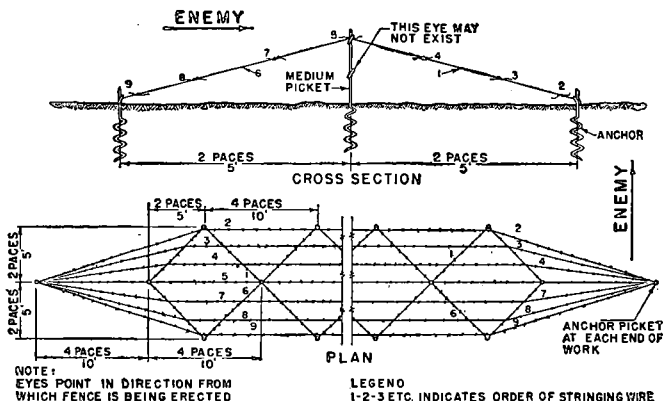


Figure 166. Low-wire entanglement.

b. Use. In tall grass or shallow water, low-wire entanglements are almost invisible and are a particularly effective surprise obstacle. However, a man can pick his way through them without much difficulty; therefore, for best results they should be employed in depth. (See fig. 135.)

139. HIGH-WIRE ENTANGLEMENT. a. Description. A high-wire entanglement (fig. 167) consists of rows of four-strand fences with wire-zigzagging between them to form a series of triangular cells.

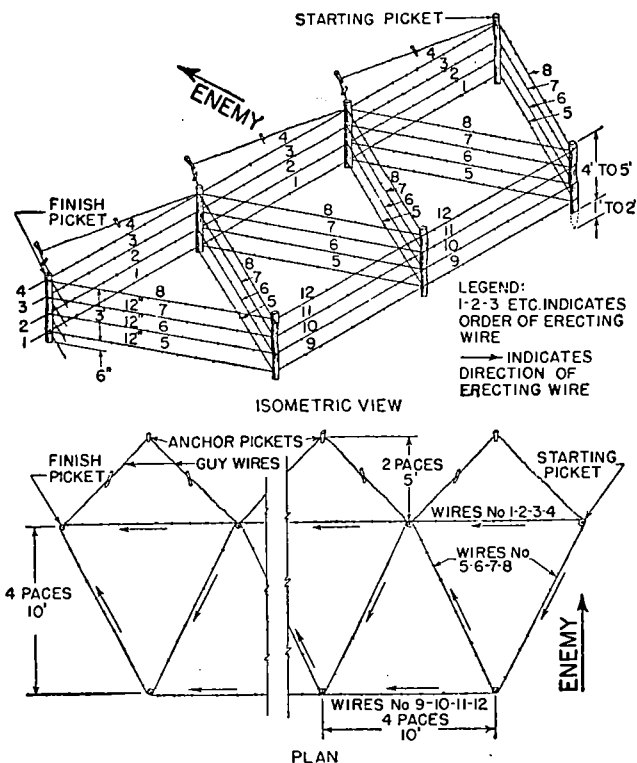


Figure 167. High-wire entanglement.

b. Construction.

- (1) Set long pickets 4 paces apart in front row. Install succeeding rows 4 paces apart with pickets half way between those in adjoining rows.
- (2) Set anchor pickets at each end of four-strand fences, 4 paces from adjoining long pickets. If

TABLE XIV. *Erection of High-Wire Entanglement*

WORKING PARTY

Varies from squad leader plus 7 to 11 men for short lengths of fence to full platoon for 300-yard fence. Crew of about one squad per 100 yards gives best results

OUTLINE OF WORK

Crew	First task	Second task
Two-thirds of working party.	Lays out pickets, front row first. First man paces off front row. Rear-row pickets are placed by estimating interval between front-row pickets.	As first task is completed, men move to head of work and start installing wires. First team installs bottom fence wire in front fence, and succeeding teams install next wires in order. Men work in teams of 2 or 4 depending on number available. When 4 men work on one team, 2 men carry the reel and 2 men make ties.
One-third of working party.	Installs front-row pickets, returns to head of work, and installs rear row.	
Senior NCO	General supervision.	

Note. For additional stability, guy wires may be added when time permits.

guy wires are used, set anchor pickets 2 paces from front and rear fences opposite midpoint of space between long pickets.

- (3) Construct entanglement, working on the friendly side of the fence; string wires from bottom to top. For erection procedures, see table XIV.

c. To expand obstacle. Increase depth and effectiveness of the entanglement by adding rows, installing front and rear aprons, and placing spirals of loose wire in triangular cells.

140. OTHER PORTABLE OBSTACLES. a. Spirals of loose wire. The effectiveness of wire entanglements is increased by filling spaces in and between obstacles with spirals of loose wire, which hinder lateral movement of troops within the entanglement. To prepare a spiral—

- (1) Drive four 3-foot posts in ground to form a diamond 3 feet by 1½ feet.
- (2) Wind 75 yards of barbed wire tightly around frame. Start winding at bottom and spiral gradually to top.
- (3) Remove wire from frame and tie at quarter points for ease in carrying to site where it is to be opened and used.
- (4) If large quantities of spirals are needed, use winch to coil wire.

b. Knife rest. The knife rest (fig. 168) is a portable wooden or metal frame strung with barbed wire. It is used wherever a readily removable barrier is needed,

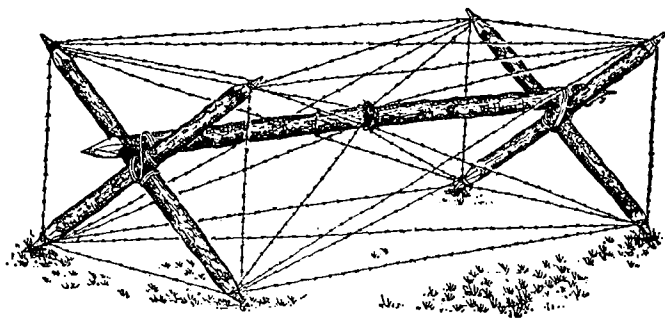


Figure 168. Knife rest.

such as a road barricade. With a metal frame, it can be used as an underwater obstacle in beach defenses.

141. COMBINATION BANDS. Combination bands can be built from the elements of the various entanglements discussed in paragraphs 139 and 140. These bands form

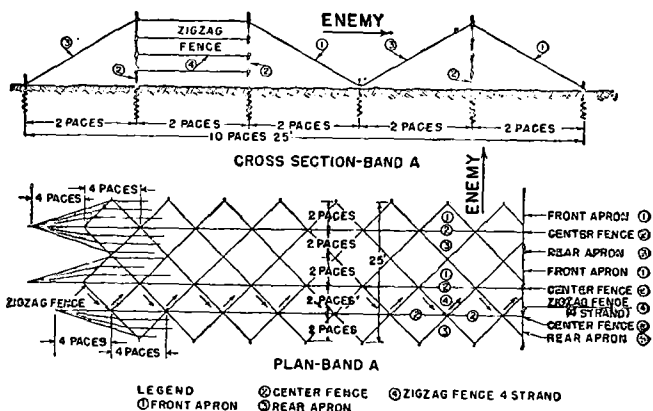


Figure 169. Combination bands of wire obstacles.

effective obstacles which are much more difficult to breach than a single belt. Portable obstacles placed in the spaces between belts or bands in a zone add greatly to the zone's effectiveness and help hide gaps. Variation in construction makes it difficult to develop standard methods of passage. (See fig. 169.)

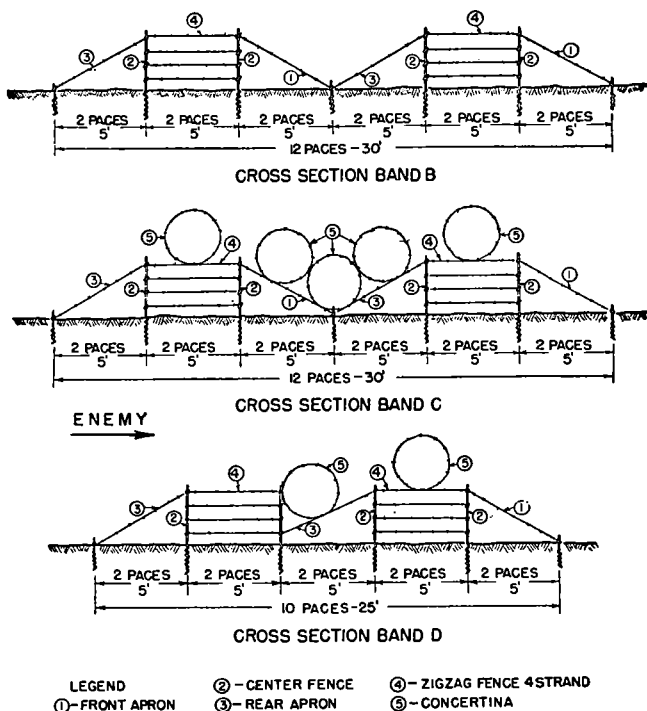


Figure 169. Combination bands of wire obstacles—Continued.

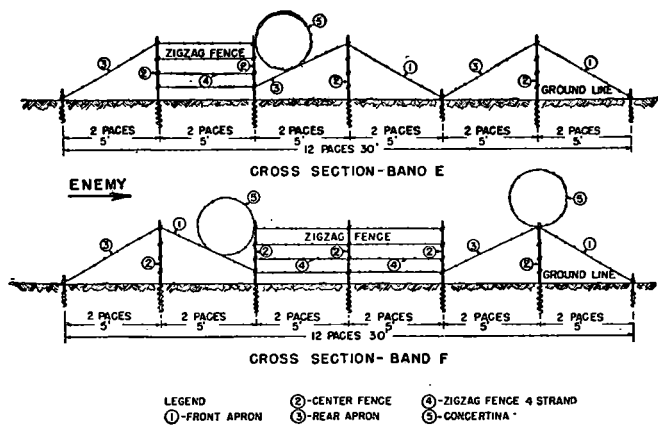


Figure 169. Combination bands of wire obstacles—Continued.

Section IV. ESTIMATING MATERIAL AND LABOR REQUIREMENTS

142. GENERAL. Most wiring materials must be brought up from engineer depots in rear areas. The ability of the responsible officer to estimate anticipated requirements in many cases determines whether they will be on hand when needed. Tables XV and XVI give data which aid in estimating material and man-hours needed for different types of obstacles, and the strength required of carrying parties. Labor requirements given in these tables are for daylight work; for night work, man-hours must be increased 50 percent.

TABLE XV. Wire Entanglement Materials

Material	Weight (pounds)	Length (feet)	Number carried by 1 man	Weight of man-load (pounds)
Reel.....	105	1,200	$\frac{1}{2}$	52.5
Bobbin.....	8-9	90	4-6	32-54
Standard barbed-wire concertina.	55	50	1	55
Expedient barbed-wire concertina	30	20	1	30
Screw pickets:				
Long.....	9	$4\frac{5}{8}$	4	36
Medium.....	6	$2\frac{3}{4}$	6	36
Short.....	4	$1\frac{3}{4}$	8	32
U-shaped pickets:				
Extra long.....	16	8	3-4	48-64
Long.....	10	5	4	40
Medium.....	6	$2\frac{3}{8}$	6	36
Short.....	4	2	8	32
Wooden pickets:				
Extra long (3- to 4-inch diam- eter).....	17-23	7	2	34-46
Long (3- to 4-inch diameter)...	12-16	5	3	36-48
Short (2- to 3-inch diameter)...	3-6	$2\frac{1}{2}$	8	24-48

TABLE XVI. *Material and Labor Required for 300 Yards of Various Wire Entanglements*

Type of entanglement	Pickets				400 yd reels ¹	Concertinas	Staples made of ½-in round drift pins	Weight of material per linear yd of entanglement ²	Man-hours to erect 300-yd of entanglement ³
	Extra long	Long	Medium	Short					
								<i>Pounds</i>	
Double-apron 4- and 2-pace.....		91		182	12-13			10	54
Double-apron 6- and 3-pace.....		61		122	11-12			7	45
High-wire (less guy wires).....		181			15-18			12	72
Low-wire 4- and 2-pace.....			91	182	9			7.5	45
Four-strand fence.....		91		2	2½-4			4	18
Triple expedient concertina.....	46	92		6	3	135	270	21	90
Triple standard concertina.....		146		4	2	54		16	27

¹ Lower number of reels applies when screw pickets are used; higher number when U-shaped pickets are used. Add difference between these two to the larger number when wooden pickets are to be used.

² Average weight when any issue metal pickets are used.

³ With exception of triple expedient-concertina, man-hours are based on use of screw pickets. When driven pickets are used, add 20 percent to man-hours. With experienced troops, reduce man-hours by one-third. Increase man-hours by 50 percent for night work.

143. REQUIREMENTS FOR A BATTALION DEFENSIVE POSITION. a. **Minimum requirements.** The rule-of-thumb for determining minimum requirements of length of wire for a battalion defensive position is—

- (1) Length of front of position by $1\frac{1}{4}$ by length of tactical wire entanglement.
- (2) Length of front of position by 5 by length of protective wire entanglement.
- (3) Length of front is taken as a straight line distance between limiting points.

b. **Example.** Assume an 1800-yard front. A four- and two-pace double-apron fence is to be used for tactical wire, and a four-strand fence for protective wire. Table XVI gives the weight of these fences per linear yard as 10 pounds and 4 pounds respectively.

$$1800 \times 1\frac{1}{4} \times 10 = 22,500 \text{ pounds} = 11.25 \text{ tons of tactical wire.}$$

$$1800 \times 5 \times 4 = 36,000 \text{ pounds} = 18 \text{ tons of protective wire.}$$

Total: 29.25 tons of material required.

c. **Alternate positions.** When there is time, the defensive position is strengthened by preparing alternate positions for the support platoon and reserve company. In that case, the rule-of-thumb for finding the length of protective wire entanglement cannot be applied, because the amount of protective wire needed depends on the number of alternate positions prepared.

CHAPTER 7

OTHER OBSTACLES

Section I. OBSTACLES FOR FIELD FORTIFICATIONS

144. GENERAL. In addition to standard mine belts and wire barricades, there are numerous other ways of obstructing, delaying and channelizing an enemy assault. The best way is to improve natural obstacles. This not only reduces the expenditure of time, labor, and materials but makes camouflaging and concealing the obstacles for the enemy a relatively simple matter. It also aids in surprising and disrupting an enemy offensive action. Every opportunity is taken to confuse the enemy and to force a cautious, slow approach to, and dismounted reconnaissance of all defiles and bends in, roads. To help accomplish this, obstacles are sited on reverse slopes and around blind curves wherever possible. Maximum use of deception also is made by—

a. Installing dummy mine fields, including some booby traps and live mines, to inflict casualties and force the enemy to make a cautious and thorough search of the area. Dummy mine fields also effectively fool the aerial observer and aerial-photograph interpreter.

b. Erecting camouflage screens of wire mesh or cloth along roads. These are used primarily to screen exposed routes and positions from enemy observation; but are effective obstacles if placed in depth. If the first few are undefended, the enemy may become careless, discontinue dismounted reconnaissance, and attempt to charge

through succeeding screens, some of which should hide defended obstacles.

c. Spreading canvas strips, straw, foliage, or similar material to cover sections of roadway. Some of these may conceal ditches, mines, or booby traps; others are harmless.

d. Concealing antitank mines in trees felled across the road. A tank which attempts to crash through is stopped within the obstacle, thus making the block more effective.

145. WINTER OBSTACLES. In winter, the obstacle effect of streams and swamps steadily declines with increasing cold until they become completely frozen and are no longer an obstacle. However, deep, loose snows and icy roads provide a greater abundance of natural obstacles than is found in warm weather. Water poured on hilly roads freezes, making an extremely effective obstacle against wheeled and tracked vehicles. The effect of steep inclines and gullies is increased by deep snow and ice. Deep snowbound road ditches can become tank traps. Movement of heavy armor and vehicles in deep snow-covered terrain usually is possible only on roads, and then only after trails or roadways have been cleared. Road obstacles therefore are especially important in winter. In Arctic regions, study the direction of the prevailing winds, snowfall, and topography so that the placement of obstacles or breaks will accelerate the enlargement of snow barriers.

a. Parallel snow walls, as shown in figure 170, are an effective tank obstacle. The snow must be packed hard. The walls are most effective when sited on an upgrade.

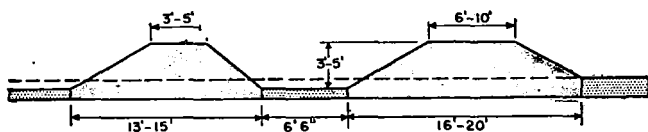


Figure 170. Antitank obstacle of packed snow.

b. Antitank obstacles in frozen bodies of water (fig. 171) may be constructed in the following manner: an opening about 10 to 13 feet wide is cut into the ice, and the cut blocks then are slid under the firm ice where they are carried downstream by water action. The openings then are closed with a light frame covered with cloth, brush, or tarpaper and topped with snow. The effectiveness of such obstacles depends upon the ability

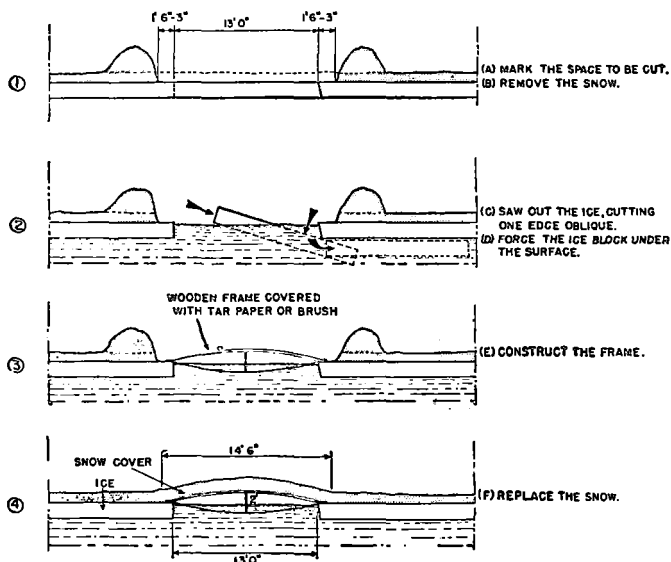


Figure 171. Antitank trap in frozen water.

of the covering material to keep the water in the channel from freezing. The snow cover must be not less than 4 inches; otherwise the water will freeze again. A well-made trap remains effective from 1½ to 2½ months in temperatures from 5 to -13° F., provided it is inspected and maintained frequently.

146. BRIDGE DEMOLITION. Bridge demolitions are effective obstacles if the water course spanned is deep and wide enough to stop mechanized units; or, if over a roadway, as in figure 172, the resulting debris is sufficient to stop vehicles. Water 3 feet deep stops most wheeled vehicles provided the vehicles are not water-proofed; water 6 feet deep generally stops medium tanks. FM 5-25 gives details of execution of bridge



Figure 172. Demolition of an overpass to create a road block.

demolition. Demolitions of overpasses over highways form effective obstacles to road traffic. (See fig. 172.)

147. ANTITANK DITCHES. a. General. In prepared defensive positions, antitank ditches supplement natural obstacles. They usually are employed in conjunction with wire entanglements and mine fields in particularly flat, open terrain, just inland of beaches, or in other locations where the terrain and situation warrant the expenditure of the necessary time and labor. (See figs. 173 and 174.) Although tank ditches never stop a tank attack, they can delay or channel it.

- (1) Mechanical trench diggers, other mechanical equipment, and explosives are used in digging antitank ditches to lessen expenditure of time



Figure 173 Antitank ditch as part of a beach defense.

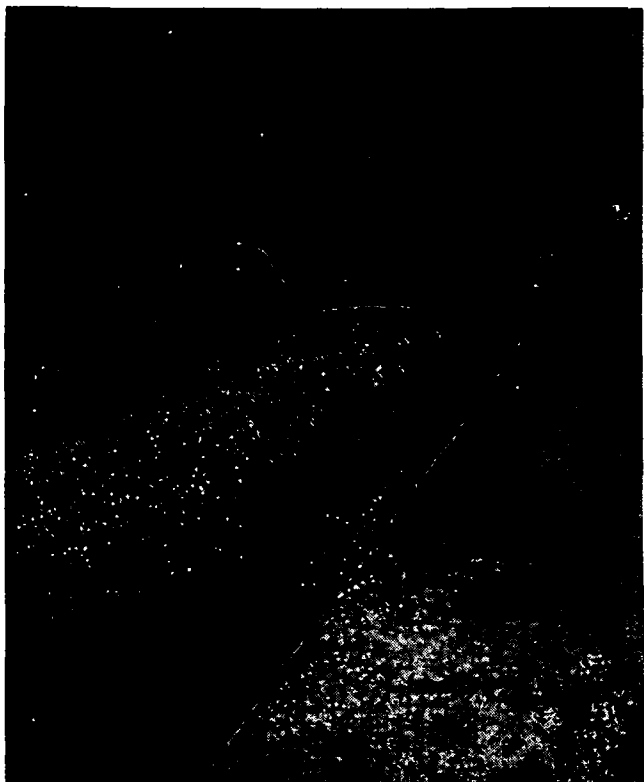


Figure 174. Antitank ditch in open country.

and labor. Ditches should be concealed as much as possible from ground observation by taking advantage of trees, brush, or folds in the ground so the enemy mechanized vehicles come upon them unexpectedly. Flooding a ditch with water makes it more effective, more difficult to breach, and helps deny enemy foot

troops use of the ditch as a protected firing position.

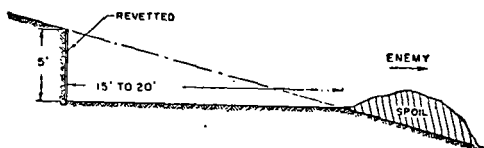
- (2) The tank ditch offers the enemy favorable covered positions for penetrating friendly defenses. Consequently, tank ditches normally are built in the rear of the main line of resistance in defensive positions and are most effective when echeloned in depth to protect divisional artillery against an enemy armor penetration.
- (3) Tanks often become separated from their infantry support and must reassemble to make new preparations for overcoming antitank obstacles. At these times they are vulnerable to artillery and antitank weapons, and especially to mobile antitank weapons located in the area in front of and behind antitank ditches and obstacles.

b. Types of ditches. Ditches with a triangular or trapezoidal cross section are used most often.

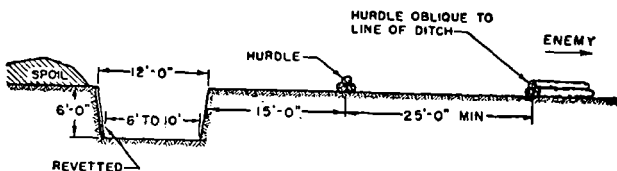
- (1) *Triangular ditches* are constructed as shown in figure 180. They are relatively easy to build, but a tank stopped in them generally can back out and try another route.
- (2) *Sidehill cuts* (fig. 175) are variations of the triangular ditch and have the same advantages and limitations.
- (3) *Trapezoidal ditches*, built as shown in figure 175, require more time and labor but make a stronger obstacle. If they are dug deeper than the highest part of the tank tread, tanks entering them will be trapped. When used in this



① **Triangular antitank ditch.**



② **Sidehill cut.**



③ **Trapezoidal antitank ditch.**

Figure 175. Three types of antitank ditches.

manner, a ditch should be covered and camouflaged so its existence will not be suspected.

- (4) In winter, antitank ditches may be camouflaged to resemble a standard trench (fig. 176.)

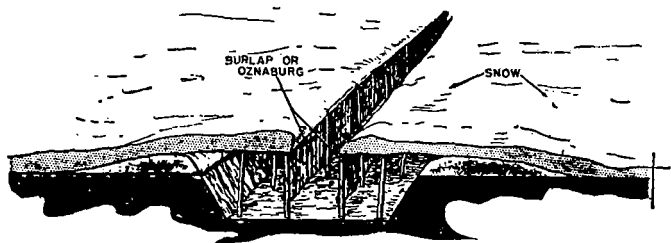


Figure 176. Antitank ditch camouflaged to resemble a standard trench.

148. CRATERS. a. Description.

- (1) Crater-type obstacles usually are limited to roads or trails and may be prepared in several ways. One method is to place charges in culverts under roads. The charges are detonated only when the enemy is about to overrun the obstacle. Thus, a temporarily effective road block is created *if* the areas on the flanks of crater are mined or otherwise covered by anti-tank weapons. Craters are most effective if the road shoulders slope sharply or rise steeply, as in mountainous terrain, thus preventing the obstacle from being bypassed.
- (2) Craters also are prepared in roads with insufficient culverts by digging holes in the road surface and placing explosives in the holes. A truck-mounted earth auger, if available, will expedite digging holes to receive explosives in road cratering operations. As in the previously mentioned method, the explosives are detonated only when it becomes apparent that an enemy attack will overrun the obstacle. The

charge holes are covered with removable planking, empty signal-wire reels, or other suitable material which allows vehicles to pass until the obstacle is used. (See fig. 177.)

b. Construction. Craters are constructed by hand labor, explosives, or earth-moving machinery. Pick and shovel work is by far the most time-consuming, but may be the only means available. (See FM 5-25 for use of explosives in this work.) To be effective, ditches made by explosives must be improved by making the slopes steeper, removing lips and, possibly, by revetting. Triangular and sidehill cut ditches are constructed most readily by using a combination of explosives and angle-dozers.



① Square charge holes covered with planking

Figure 177. Preparing two types of craters for road blocks.



② Round charge holes covered by empty wire reels

*Figure 177. Preparing two types of craters for road blocks—
Continued*

149. PANJI JUNGLE TRAP. a. Panji traps are most effectively placed when they are merged with natural jungle obstacles. In the defense, they may be used either as barricades around camps or as barriers to impede the advance of an attacking force. In the offense, they may be constructed behind enemy lines to stop or hinder any retreat. Enemy patrols can be disbanded by a skillful use of these traps in conjunction with covering snipers.

b. A pit, 4 to 6 feet deep, 4 to 6 feet long, and 3 to 4 feet wide, is dug in the middle of a jungle trail or at a stream crossing. A number of long, sharp panjis (bamboo spikes sharpened to a needle point) are placed

upright in this pit, with their fire-hardened points slightly below ground level (see fig. 178.) The pit is concealed by a flimsy lid consisting of a bamboo lattice covered with a few bamboo creepers and camouflaged with mud or leaves to blend with the surrounding terrain. Anyone falling into the pit is instantly impaled on the spikes.

c. Similarly, a slit trench can be so placed that enemy troops will be likely to use it. Like the cover of the panji pit, the bottom of this trench is false, and underneath it are sharp panjis, which will impale anyone jumping into the trench.

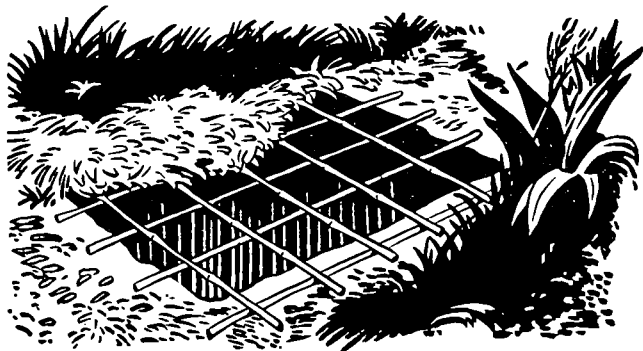


Figure 178. Panji jungle trap.

150. BAMBOO WHIP. A 3-inch bamboo pole can be bent back across a jungle path in such a way that when it is released, the force of the blow will kill the man who tripped it. To insure effective results, panji spikes can be attached to the end of the whip, as shown in figure 179. The whip is held in position by a bamboo creeper or by wire, with a peg at the end of the wire pressing against two horizontal sticks. Pressure against a trip

wire across the path withdraws the lower stick, allowing the heavy bamboo to whip forcefully across the path. If the trip wire is covered with leaves and the bamboo whip concealed by branches, the enemy is less likely to detect the trap.



Figure 179. Bamboo whip.



Figure 179. Bamboo whip—Continued.

151. PANJI AMBUSH. Panjis also may be prepared by snipers lying in wait to ambush hostile patrols. Along the sides of the trail that an enemy patrol is likely to use, sharpened bamboo spikes, 18 inches long, are placed at 1-foot intervals and are pointed toward the trail at an angle of 45 degrees. When the hostile patrol appears, it is fired on by hidden snipers. On hearing the first shots, the instinctive reaction of the members of the patrol is to seek cover. If they dart into the undergrowth beside the trail they are impaled on the bamboo spikes.

152. LOG OBSTACLES. a. **Log cribs.** Although antitank mines generally are used to block vehicle routes, rectangular or triangular log cribs (figs. 180, 181, and 182) also are used occasionally to block earth or gravel road

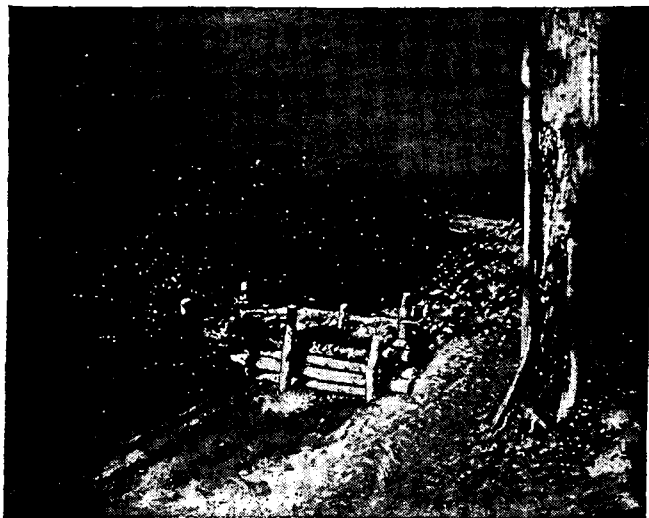
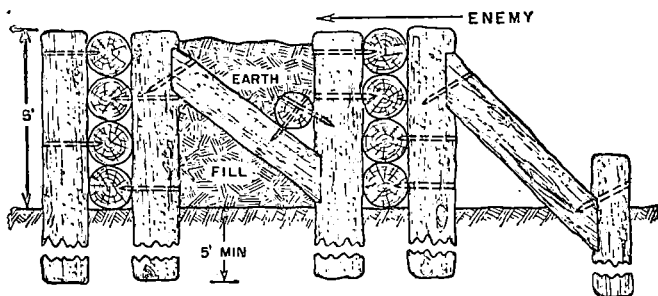
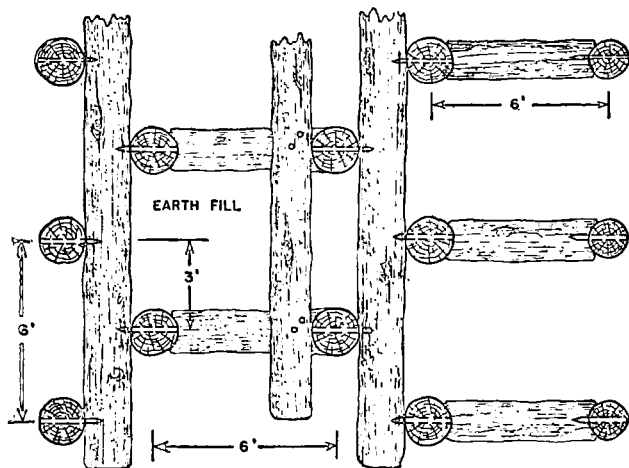


Figure 180. Rectangular log-crib road block.



CROSS SECTION



NOTE • ALL LOGS 8" DIAMETER (MIN)

PLAN

Figure 181. Plan for log-crib road block.

which cannot be bypassed readily. Unless substantially built, they will not stop heavy tanks. Construction requires a nearby supply of standing timber and enough men and tools to build the obstacle efficiently. Cribbs are filled with earth for greater strength, the fill being obtained by digging a shallow ditch in front of the obstacle. Hurdles in front of the obstacle slow down advancing vehicles and improve its effectiveness. An engineer platoon equipped with platoon tools can build 20 feet of this obstacle in 4 to 8 hours.

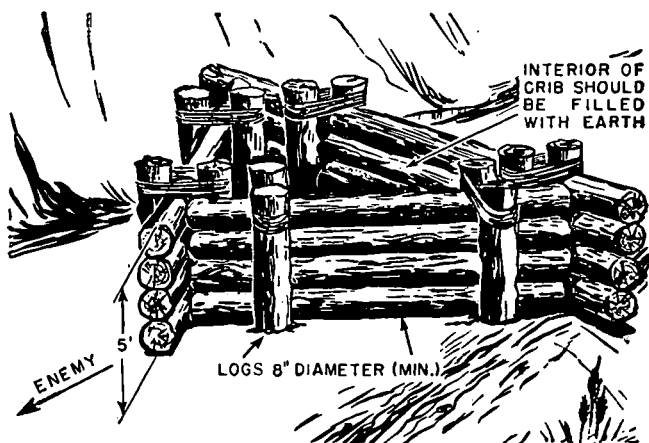


Figure 182. Triangular log crib.

b. Log posts.

- (1) A properly constructed and emplaced log-post obstacle is almost proof against tank assaults and is an unprofitable target for artillery. However, it requires hardwood posts 9 feet long and at least 15 inches in diameter and therefore can be built only in heavily timbered country. In soft or medium soil, the posts must be set by a pile driver so they will not sink under a tank's weight. Wire entanglements often are woven between the posts, as in figure 183.

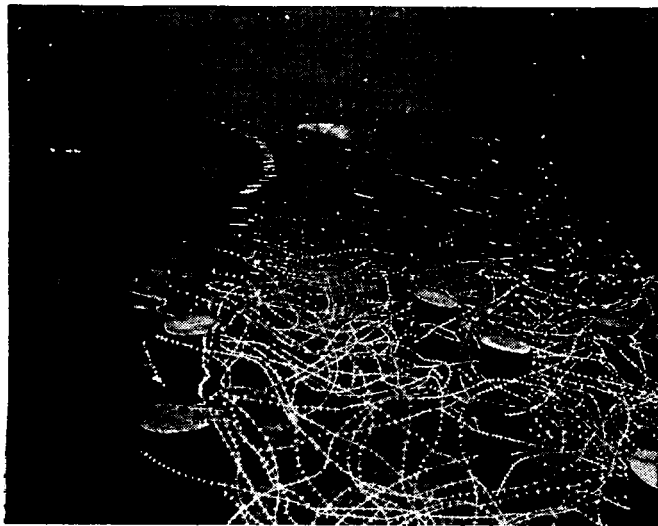


Figure 183. A belt of antitank log obstacles.

- (2) In hard soil, posts are set upright in prepared holes. They are placed in rows, with each post

at varying heights above ground, and several feet apart. (See fig. 184.) Logs may be laid horizontally between rows and wired together to increase the strength of the obstacle.

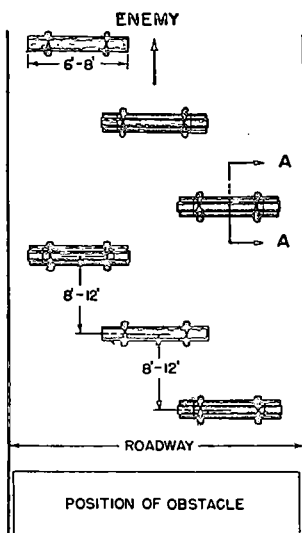


Figure 184. Log-post road block.

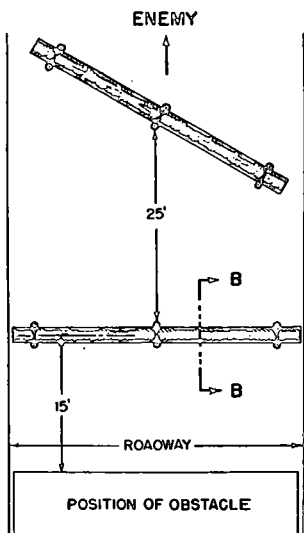
- (3) Hurdles placed in front of the obstacle increase its efficiency. Rate of construction of log obstacles is approximately as follows:
 - (a) Using pile-driving equipment, 2 noncommissioned officers and 16 men—4 to 6 hours.
 - (b) Using power earth auger, 1 noncommissioned officer and 8 men—2 to 2½ hours.
 - (c) Using hand tools and one engineer company—3 hours.

c. hurdles. Hurdles normally supplement other arti-

ficial obstacles. They are built of logs 18 inches or more in diameter or of several 10-inch diameter logs wired together. Two methods of employing hurdles are shown in figure 185. Hurdles can be employed alone on slopes so steep that a tank must climb it at low speeds. The added obstacle of the hurdle will stop the tank.

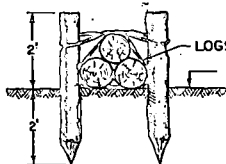


EMPLOYMENT OF STAGGERED 6'-8' HURDLES (3-10" LOGS OR 1-18" LOG)



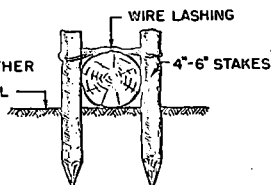
EMPLOYMENT OF 18' LOGS AS HURDLES

PLAN



SECURING 3 LOG HURDLE

SECTION A-A



SECURING 18' LOG HURDLE

SECTION B-B

Figure 185. Two methods of employing hurdles.

d. Abatis.

- (1) An abatis (fig. 186) is constructed by felling trees at an angle of about 45 degrees to the enemy's path of approach. The trees should be left attached to the stumps to prevent rapid removal. To stop tanks, the trees should be at least 3 feet in diameter. Smaller trees will stop wheeled vehicles. When built to increase the obstacle value of thin woods, the abatis must be at least 30 yards deep. A road through thick woods can be blocked by an abatis 75 yards deep. Using hand tools only, one engineer platoon can build 75 yards of abatis in 8 hours. Use of gasoline power chain saws decreases this time considerably.



Figure 186. An abatis.

- (2) Charges or captured mines may be used to fell trees rapidly. This is done by cutting a notch in each tree with an ax. The charge is placed in the notch and fastened securely. The charges then are connected with primacord (fig. 187) and detonated.

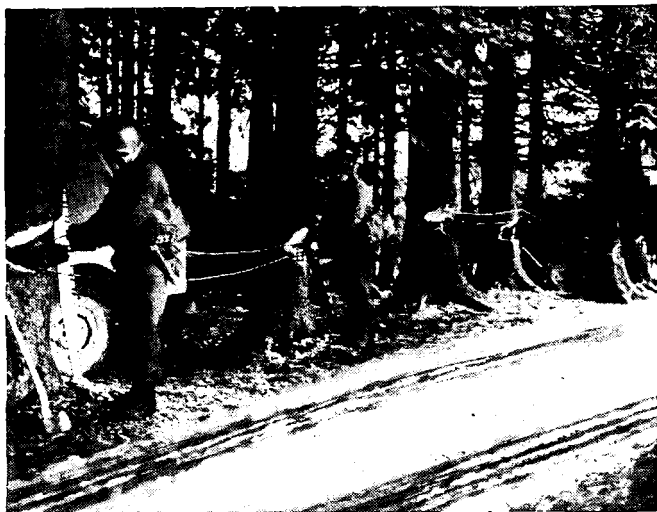


Figure 187. Connecting charges in trees to be used for constructing an abatis.

153. CABLE OBSTACLE. One type of harassing obstacle intended to damage an enemy vehicle is erected as follows: A tree on the side of a road is cut almost through; a steel cable or wire, tied to this tree, is stretched across the road. A passing vehicle, striking the wire, will cause

the tree to fall on and damage the vehicle. (See fig. 188.)



Figure 188. Cable obstacle.

154. STEEL OBSTACLES. a. General. Steel and concrete obstacles generally are built into the defense system of permanent protective installations (described in TM 5-310).

b. Types.

- (1) One type of steel obstacle is shown in figure 189. The steel I-beams are emplaced in previously prepared holes across a road junction to form an antitank block. The manhole-like covers in the background were used to cover the holes before the I-beams were installed, permitting passage of friendly traffic until the enemy's advance made necessary the emplacement of the beams.



Figure 189. Steel beam antitank road block.

- (2) Another type of steel obstacle is shown in figure 190. It is used chiefly as a part of beach defenses to supplement other types of obstacles in stopping tanks and vehicles.

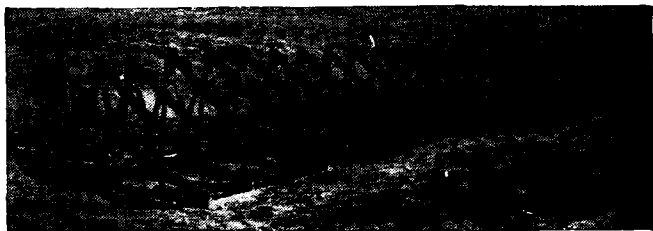


Figure 190. Steel ramp.

155. STRENGTHENING NATURAL OBSTACLES. The only real tank-proof obstacles are steep banks and slopes, unfrozen swamps (minimum depth about 3 feet), and broad, deep streams. These obstacles must be supported by covering fire to be fully effective. Enemy tanks stopped by natural obstacles not covered by fire merely deploy along the front to a more passable point in the terrain, increasing the weight of armor assault at these points and making it more difficult to halt the attacks. Time, labor, and materials are saved by strengthening existing natural obstacles instead of building artificial ones. This can be done by—

a. Cutting the banks of streams, ravines, ditches, and embankments to increase the dimensions and to present a nearly vertical face to approaching vehicles. Spoil, logs, and, if necessary, revetments are placed on the friendly side to increase its strength. Hurdles are placed on the enemy side.

b. Flooding lowlands by cutting dams or levees. Water diverted to soft or swampy ground or down slopes creates a muddy surface that is difficult for vehicles to pass.

156. CHEMICAL AGENTS. a. **Use.** Chemical agents can be used in the form of antipersonnel mines, in belts of persistent agents, and to contaminate other type obstacles. They cause delay in removing or bypassing obstacles and lower the efficiency of the attacking force. Chemical agents will be used only if the enemy employs them.

b. **Chemical mines.** The chemical land mine (fig. 191) is a thinwalled container filled with mustard gas; it

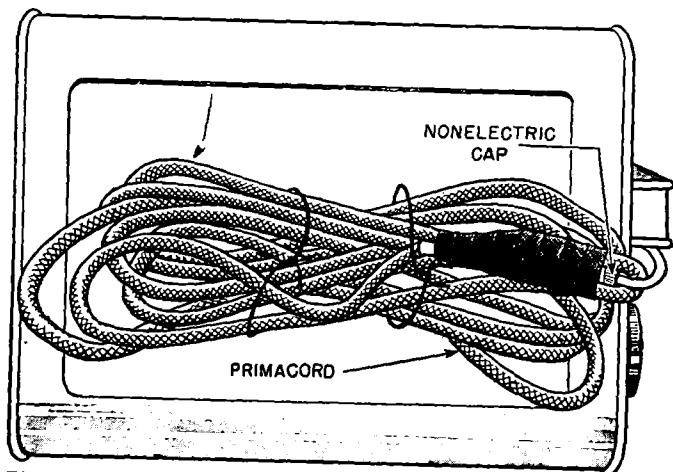
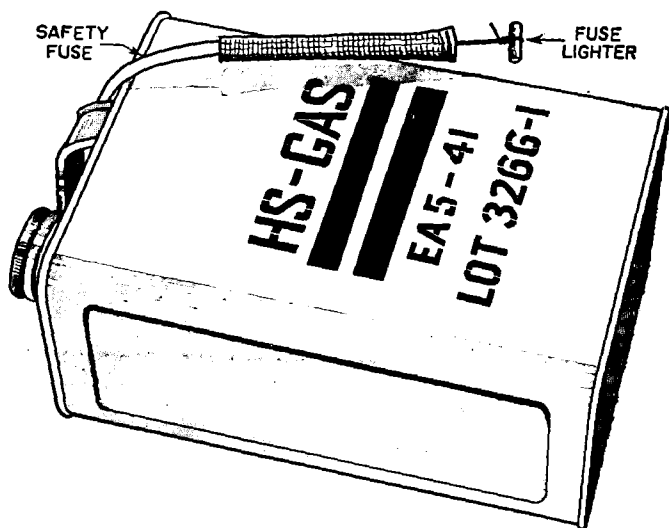


Figure 191. Chemical land mine primed for firing with time fuse.

weighs 12 pounds. Chemical land mines are packed six to a crate weighing about 90 pounds. The mine has a special bursting charge which can be fired with electric or nonelectric caps. The mine is placed with the charge underneath and on explosion throws liquid 3 to 5 yards in the air and contaminates an area 20 to 25 yards in diameter. If the burster charge is not available, primacord makes an effective substitute. The length of primacord used controls the strength of the explosion and the size of the area contaminated. It varies from 3 feet for small areas to 8 feet for large areas. The primacord is folded to form a bundle 8 or 9 inches long. To contaminate roads, chemical mines are staggered along each edge at intervals of 17 yards, or a total of 200 mines per mile of road. An obstacle can be contaminated by firing one or two chemical mines on it. Chemical corps personnel are responsible for more extensive contaminations.

c. Smoke.

- (1) The use of smoke in tactical assaults or defensive actions is a valuable aid in screening separate, important actions such as removal of enemy obstacles, assault crossing of rivers and streams, beach landings, and other individual phases of a broad attack plan. Smoke must not be used for small actions unsupported by a general offensive or defensive maneuver, because smoke itself will disclose the general area of activity and draw attention to what otherwise might be an undiscovered operation. Smoke is best employed when there is no wind, and in valleys, along watercourses, or

damp places where it tends to cling longer. Smoke lingers longer in cold climate than in warm climates.

- (2) The obstacle effect of smoke prevents the enemy from directly observing local activities of friendly troops. It causes him to disperse his forces along the entire smoked area, thus permitting more freedom of action and maneuverability to the screened troops.

157. FIRE. Under suitable conditions, burning grass may be used as an effective obstacle or offensive weapon against attacking hostile troops. A strip of grassy area is soaked with a gasoline-oil mixture and ignited by tracer and incendiary ammunition in the face of the attacking enemy.

158. BATTLEFIELD ILLUMINATION. The use of searchlights from covered positions on low clouds, particularly in mountains and hilly country, effectively illuminates the battlefield at night, producing illumination on the affected area similar to that of a half moon.

a. Some of the advantages of this artificial moonlight include better control of infantry night attacks; better concealment, provided by shadows, particularly on the forward sides of buildings and brush where observation of troops in such locations is denied the enemy; and easier observation for engineer operations, observation posts, and repair crews. It also does much to raise the morale of troops on cloudy, rainy nights.

b. Some of the disadvantages, many of which are eliminated by changing beam directions or light posi-

tions, are that it furnishes inadequate illumination for extensive night tank operations in rugged terrain; provides the enemy better observation of friendly troop movements and aids him on reverse slopes; restricts motor movements; and facilitates enemy withdrawals in the face of attacks.

159. OBSTACLES IN DEFENSE OF AIRFIELDS. Plans for the defense of airfields and airdromes should include obstacles to prevent aircraft landing and to impede operations of enemy ground forces, including parachute or airborne troops and mechanized units. The defense of airfields is covered in FM 1-26, FM 100-15, and TM 5-255.

a. Against ground forces. All-around barrier protection, similar to that used in a battle position, is set up against mechanized penetrations and airborne troops. Wire, mines, and other obstacles are employed.

b. Against landing of hostile aircraft. Obstacles to prevent landing of hostile aircraft include—

- (1) Movable obstacles to block runways on short notice.
- (2) Prepared demolitions to be set off when seizure by the enemy cannot be prevented.
- (3) Fixed obstacles such as ditches, posts, and discarded vehicles to block interior areas not part of the runway and possible landing areas near the field.
- (4) Rows of posts high enough to strike the wings of planes attempting to land; they are installed

along the side of roads that might serve as landing strips.

- (5) Use of a rooter plow on runways and adjacent areas.

160. OBSTACLES TO THE LANDING OF AIRBORNE TROOPS.

a. There are many natural obstacles to the safe landing of gliders, such as stone walls, strong trees, sunken roads, pylons and high tension cables, deep ditches, and rough or broken ground. Artificial obstacles such as craters, parked vehicles, rock-filled oil drums, felled trees, and mine fields may be hastily constructed or erected.

b. More elaborate construction is necessary to be effective in preventing successful landings by parachute in likely drop zones. Spiked posts approximately 20 feet in height, solidly implanted in a vertical position at regular intervals of 30 feet create a serious handicap. The effectiveness is increased by connecting the tops of the poles with barbed wire and attaching booby traps to cover the entire field. (See fig. 133.)

c. The extensive use of smoke in areas where airborne operations may take place greatly increases the enemy's problems of navigation, landings, assembly, and control of troops.

161. BOOBY TRAPS. a. General. Prior to withdrawal from an area, all installations that may be of value to the enemy are destroyed. To delay enemy repair work, these demolitions should be supplemented by delay-action mines, chemical mines, and booby traps. Such devices are installed and concealed in places the enemy

is most likely to frequent to harass and delay him, to lower his morale, and to cause damage and casualties.

b. Definition of a booby trap. A booby trap is a concealed explosive charge, hidden in such a way that it will be unintentionally set off by enemy personnel.

c. Psychological effect. Booby traps are more important for their effect upon the state of mind of the enemy than because of the casualties produced. They should be planned so as to strike unexpectedly when the enemy soldier is relaxed or busying himself with a routine task. Because of a series of confusing and frightful experiences they force him to live in an atmosphere of uncertainty and fear. He should be made to dread advancing into new localities, undertaking new tasks, or entering buildings or dugouts for shelter or rest. To this end, delayed-action mines and booby traps should have infinite variety in their distribution and use, and should be particularly dangerous to those who attempt to locate or remove them.

d. Operation. The booby trap consists essentially of a charge of explosives and an operating mechanism. It uses the same detonating devices and charges as the antipersonnel mine. However, it differs from the antipersonnel mine in the variety of means employed to set off the detonating device.

e. Principles of employment. The following principles should be observed in setting booby traps:

- (1) *Preservation of outward appearance.* Care must be exercised to disturb the surroundings as little as possible and to remove or conceal all signs of the installation.

- (2) *Constricted localities.* The more constricted the site in which the booby trap is placed, the more chance there is of its being sprung and the greater the difficulty of detection and clearance. Passages, stairways, dugout inclines, and defiles are examples of effective locations.
- (3) *Concentration of traps.* Booby traps should be laid in considerable concentrations to reduce the chances of finding them all without springing some. Decoys should be used freely.
- (4) *Double bluff.* An obvious booby trap often may be used to mask a well-concealed one nearby.
- (5) *Inconveniences.* Traps may be set so as to be operated by removal of obstructions in trenches, roads, dugouts, and buildings (particularly those buildings suitable for headquarters).
- (6) *Curiosity.* The handling of souvenirs, pictures, food and drink containers, or musical instruments, may operate booby traps.
- (7) *Everyday operations.* Booby traps may be operated by opening or closing doors or windows, or using telephones, light switches, or toilets.
- (8) *Attraction.* Personnel may be attracted to a booby trap site by means such as delayed-action incendiary bombs.
- (9) *Firing.* It is advantageous to provide some or all traps with two or more methods of firing.
- (10) *Variety.* Several different kinds of booby traps should be employed in any one locality.

f. Responsibilities of all arms. Booby traps are laid only on order of division or higher commanders. Booby

traps are installed only by engineers or by specially trained troops of other arms. When booby traps are set in territory likely to be reoccupied by friendly troops, full details must be recorded, giving the exact location of each trap, its type, and the date on which it was set. This information will be forwarded to higher authority so it can be conveyed to all units concerned.

g. Examples of booby traps. Figures 192, 193, and

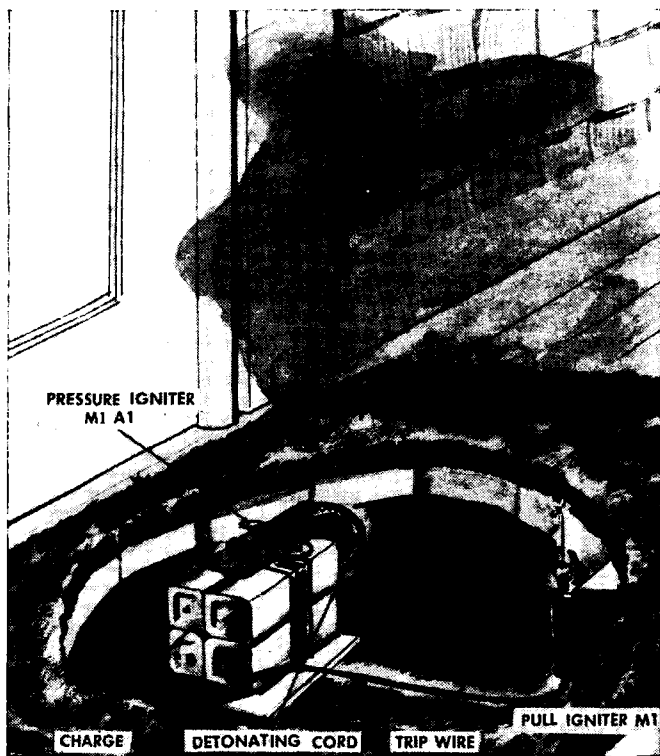


①
192. Typical booby trap.

194 show typical booby trap installations. Ingenuity will suggest many others. Booby traps are discussed in detail in FM 5-31.

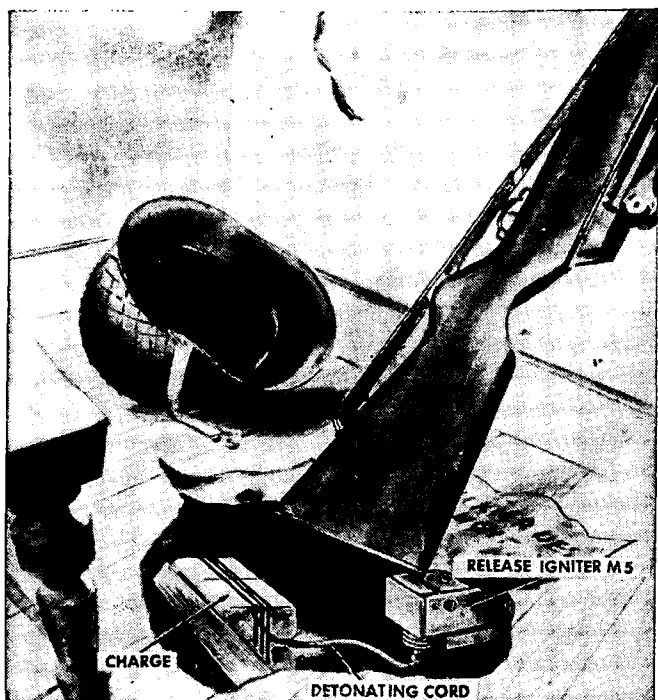
h. Installation of booby traps in abandoned material.

In a retreat, troops should evacuate all supplies and equipment; however, if this is impossible, such material



⑧

Figure 192. Typical booby trap—Continued.



⑧

Figure 192. Typical booby trap—Continued.

is destroyed. Booby traps are used, in addition to destruction, to deter the enemy from salvaging material or gathering useful information.

- (1) Figures 192, 193, and 194 show booby trap installations in various kinds of material. The installations are not to be considered as representing standard types, but rather as suggest-

ing the technique to be employed and the variety of possibilities. *The same principles and technique apply equally well to any other material.*

- (2) In figures 192, 193, and 194, the explosive is shown as three or four blocks of TNT. The amount of explosive will vary with the pur-

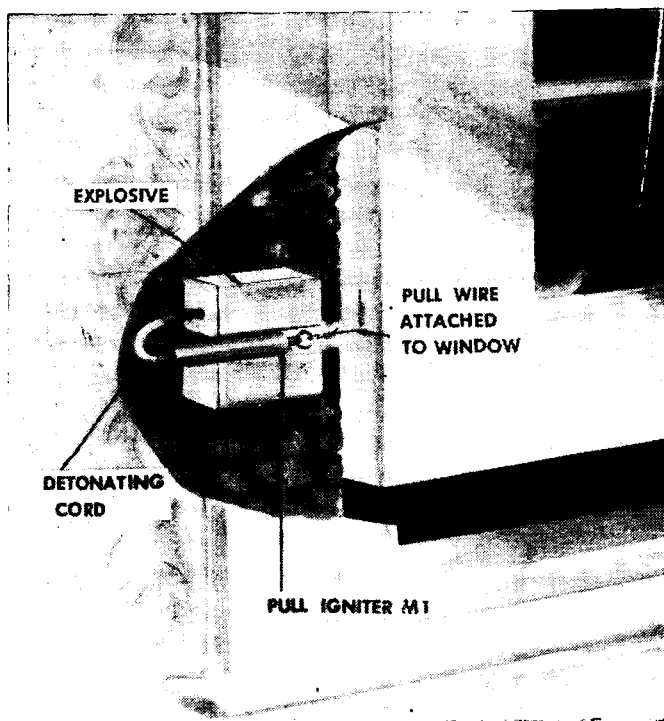


Figure 193. Booby-trapped window.

pose of the trap. For use against individuals, one block is sufficient. The charge is increased for use against groups of personnel and its effects may be made greater by taping scrap metal to the surface of the charge. See FM 5-25 for amount of explosives used in large trap mines for demolition of structures.



Figure 194. Booby-trapped truck seat.

162. DELAYED-ACTION OBSTACLES. a. General.

Denial operations may be supplemented by leaving behind delayed-action demolition mines. The purpose of these mines is to harass the enemy, to interrupt his communications at a later time, to make cities and towns less useful for shelter and comfort, and to handicap the enemy engineer effort.

b. Types of demolition mines. Demolition mines are heavy charges of high explosives. They may be of delay or contact type.

(1) *Delay type.*

(a) The delay igniter M1 (fig. 195) is a small delayed-action igniter which can be used for firing a delayed-action mine. It will operate in any position. The delay period is fixed in manufacture. The identification and safety strip provided serves two purposes.

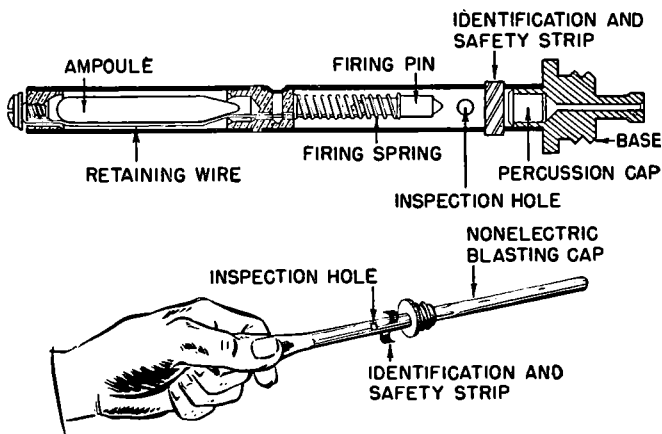


Figure 195. Delay igniter M1.

Its color is the key to the delay period ; and its location, directly above the percussion cap and separating it from the firing pin, prevents accidental firing. Therefore, in making installation, the last step taken should be removal of this safety strip. The igniters are made up in six different delay periods identified by the following colors : black, red, white, green, yellow, and blue. They are listed here in order of length, the shortest delay period being the black. Instructions for use and a temperature table are packed in each box of 10 devices. This table gives the delays under various temperatures. The black type varies from 5 minutes at 150° F. to 5 hours at 10° F. The blue type varies from 1½ hours at 150° F. to 9 days at 10° F.

- (b) *Functioning.* The delay device operates due to the corrosive action of a liquid chemical upon a metal wire. A spring-loaded firing pin is restrained in a cocked position by a wire and is freed to detonate a percussion cap when the restraining wire is eaten through by the chemical. The liquid is contained within a glass ampoule in the device and is released by crushing the part of the device that contains the ampoule. The length of delay in firing is determined by the strength of the chemical and the temperature.
- (c) *Use.* If the situation is such that a charge must be detonated at a given time, then this

device should not be used. However, if a delay, but no exact time of detonation is required, then this device can be used satisfactorily.

(d) *Advantages.* The principal advantages of this device are—

1. Ease, safety, and simplicity of installation.
2. Facility with which it can be placed in operation.
3. Absence of any indication that it is functioning, once placed in operation.
4. Compactness.

(e) *Precaution.* Under no conditions should any friendly troops approach a charge employing this delay device once it has been installed.

(2) *Contact type.*

(a) *Description.* Contact mines are actuated by pressure such as the weight of a truck, tank, railroad train (fig. 196), or man; by pull, such as the opening of a sliding door or the throwing of a light switch; or by electrical means of various kinds. Contact mines differ from antipersonnel mines only in that they are designed primarily for demolition purposes, rather than to harass and destroy personnel.

(b) *Employment.* The following types of demolition mines may be used on highways or railway lines:

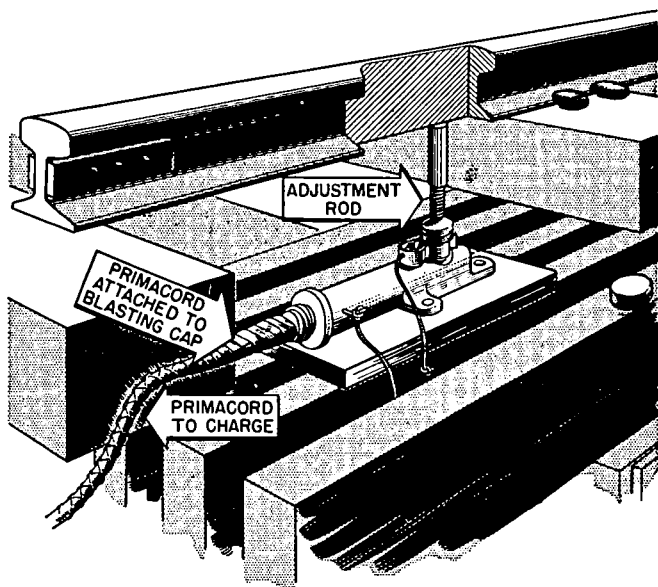


Figure 196. Installation of a contact mine under a rail.

1. Antitank mines.
2. Bridge demolitions.
3. Cratering demolitions.
4. Landslide demolitions.

c. **Summary.** Demolition mines, either contact or delay, may be used on buildings or utilities. Such mines often are very effective when installed so as to destroy key portions of important manufacturing establishments, power stations, water towers, or municipal buildings once they have been repaired by the enemy and put back in use.

Section II. BEACH AND RIVER-LINE OBSTACLES

163. GENERAL. Beach obstacles are designed to force landing craft to unload at low tide several hundred yards seaward of the high-water mark. Thus, assaulting infantry must cross a wide expanse of obstacle-studded beach covered by heavy defensive fire before reaching the high-water mark. At high tide, beach and underwater obstacles are covered by just enough water so they cannot be seen by landing craft. When the landing craft strikes the obstacles, they are disabled and the assaulting troops are forced to disembark in deep water, providing the defending artillery with a more stationary target.

a. Antiboat obstacles are constructed at varying heights so they are about 1 to 2 feet below the surface of the water at high tide. (See fig. 197).

b. Floating mines tied to obstacles under the surface of the water are effective in river defenses where the tide and current is negligible. Mines also may be attached to antiboat obstacles to blow out the bottom of vessels scraping the obstacle (fig. 198). All possible beach exits must be mined or otherwise blocked with obstacles and covered with fire.

c. Beach obstacles include wire entanglements, anti-tank and antipersonnel mines, sea walls, and element C.

164. ELEMENT C. Element C is a steel-fence obstacle made of angle irons bolted, riveted, or welded together (see fig. 199). The angle irons vary in size from 5 by 5 by $\frac{1}{2}$ inches to 3 by 3 by $\frac{1}{4}$ inches. The fence is made up of sections 10 feet wide and 10 feet high. Diagonal

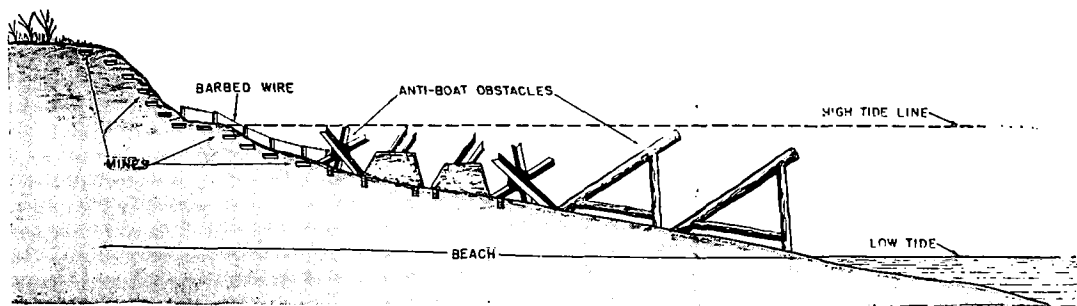


Figure 197. Antiboat obstacles in beach defenses.

braces extend back 14 feet on the friendly side of the fence. Sections may be mounted on rollers. A continuous fence is formed by joining sections with heavy steel cables, steel bars, and chains. Element C may be used both on land as road blocks or on beaches as boat obstacles.

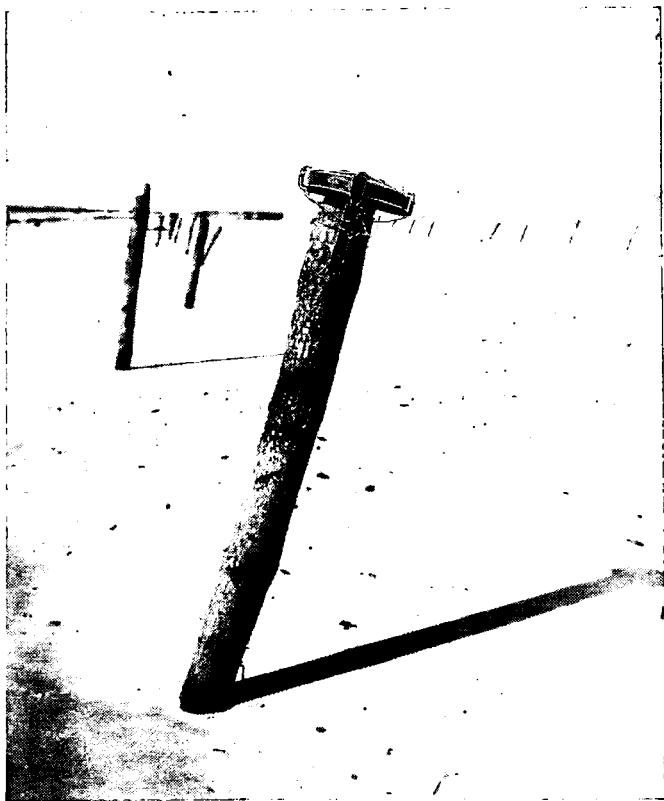


Figure 198. Mined antiboat obstacle as it appears at low tide.

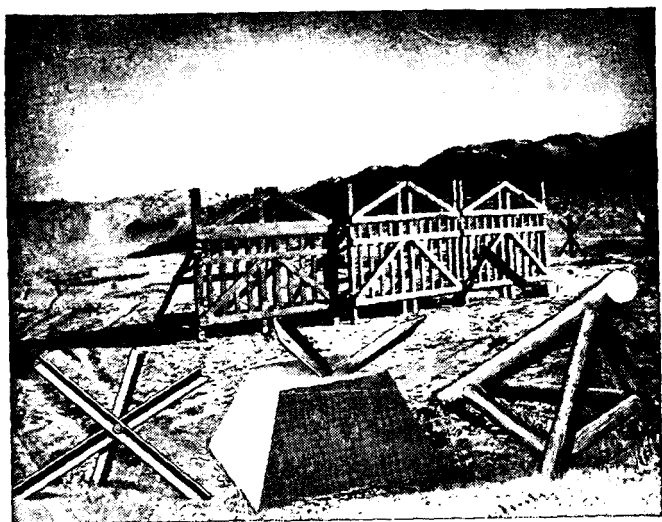


Figure 199. Various types of beach obstacles.

165. LOG ANTIBOAT OBSTACLE. The log antiboat obstacle constructed of logs at least 8 inches in diameter, forms a braced tripod with its longest leg pointing toward the direction of expected assault. (See fig. 199). This leg may be capped with a waterproofed antitank mine. Constructed in varying sizes so they are covered by 1 to 2 feet of water at high tide, these obstacles are placed on beaches from the low-tide mark back to about halfway to the high-tide line.

166. HORNED SCULLY. The horned scully is a sunken obstacle designed to tear holes in the bottoms of wood or steel boats. It is used in water too deep for debarkation of troops or equipment. It consists of a tapered

block of concrete with two steel rails projecting from the top (fig. 199). Two sections of chain are embedded to simplify handling the obstacle. The block is 50 inches high, 82 inches square at the bottom and 46 inches square at the top. The rails project 2 to 4 feet from the block. A unit contains 4 cubic yards of concrete and weighs about 8 tons. For river-line defense, the block is smaller, depending on the expected size of enemy craft.

167. HEDGEHOG. The hedgehog is made of 6-foot lengths of channels or angle irons. (See fig. 199.) It is shipped in 2 or 3 sections and assembled in the field. The center connection is bolted, preferably with gusset plates to prevent shearing of bolts. It weighs about 500 pounds. Hedgehogs are not fastened to each other or to the ground, but depend on revolving under a tank or boat and bellying the tank or ripping a hole in the boat. They are used in rows, at least 150 hedgehogs to 100 yards of front, and form an obstacle of about the same weight as tetrahedrons.

168. WIRE ENTANGLEMENTS. Wire entanglements are used as antipersonnel obstacles, but also will stop light landing craft. They are placed inshore of scaffolding or sunken obstacles and, if possible, are covered by enfilading machine-gun fire. Entanglements normally are built at low tide. They require constant maintenance, particularly if placed in surf. Wire also is erected on beaches or river banks, often with antitank and antipersonnel mine fields. Almost all of the types of wire obstacles mentioned in section III, chapter 6, may be used in conjunction with other beach and underwater obstacles.

169. IMPROVISED UNDERWATER OBSTACLES. The obstacles described in **a** through **i** below are made with natural materials, some supplemented with barbed wire, and are nearly as effective as steel or concrete obstacles. Wherever possible, mines should be used with the obstacles to increase their effectiveness and to hinder removal by enemy underwater demolition teams.

a. Rock Mounds. These consist simply of mounds of rock about 3 feet high, 12 feet square, and staggered at 10 to 15 feet intervals on the outer edges of reefs or likely landing beaches.

b. Wire fences (fig. 200) Fences of this type consist of barbed wire strung on a series of upright posts, often interspersed with "Spiders" (tetrahedra) (see **e** below) and light knife rests (par. 140**b**).

c. Post lines. Short, stout, vertical logs spaced at intervals of about 5 feet along the shore, and taller posts (4 x 4 or 6 x 6 timbers), similarly spaced and inclined seaward, situated further offshore, are effective against light landing craft, especially with mines attached to their tops. (See fig. 201.)

d. Crib. Log cribs, about 10 feet long and 4 feet wide, may be filled with rocks, and spaced at intervals of about 5 feet and far enough out so that at high tide the top of the crib is a few inches under the water. (See fig. 202.)

e. **Tetrahedra** (fig. 203). These are similar to the steel prefabricated tetrahedra but are made of logs lashed or bolted together. They may be filled with rock and connected with barbed wire.

f. **Spiders** (fig. 204). A variation of the tetrahedron, the spider is constructed of logs or poles, either braced by cross members at the base and weighted with rocks, or anchored with its ends buried in the sand. Spiders are placed at intervals of from 15 to 30 feet, and often are incorporated in wire fences.

g. **Pillars**. These are triangular structures of logs, filled with rock, about 6 feet high and 7 to 9 feet across one side. They may be connected by barbed wire. (See fig. 205.)

h. **Log barricades**. Barricades are constructed of logs or poles, sometimes strung with barbed wire, and spaced at intervals of 6 to 10 feet. (See fig. 206.)

i. **Rock walls** (fig. 207). Rock walls are about 4 feet high and from 3 to 4 feet wide, in sections or in continuous lines. They should be mined and topped with concertina.

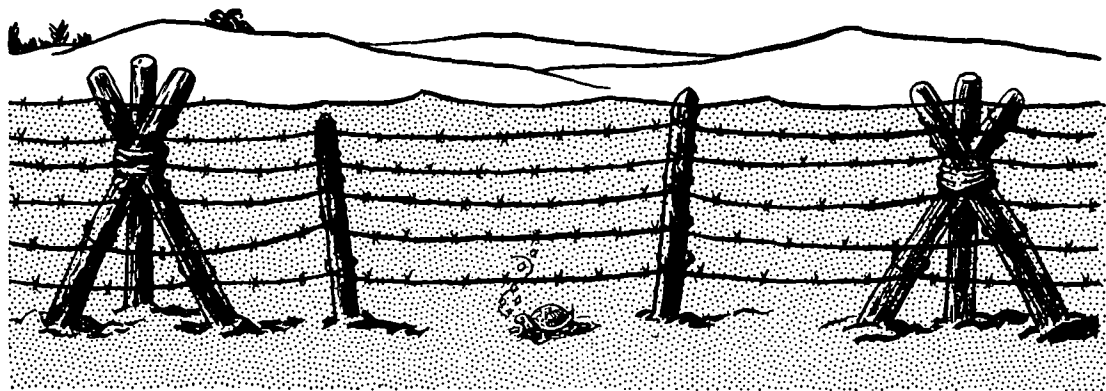


Figure 200. Wire fences.

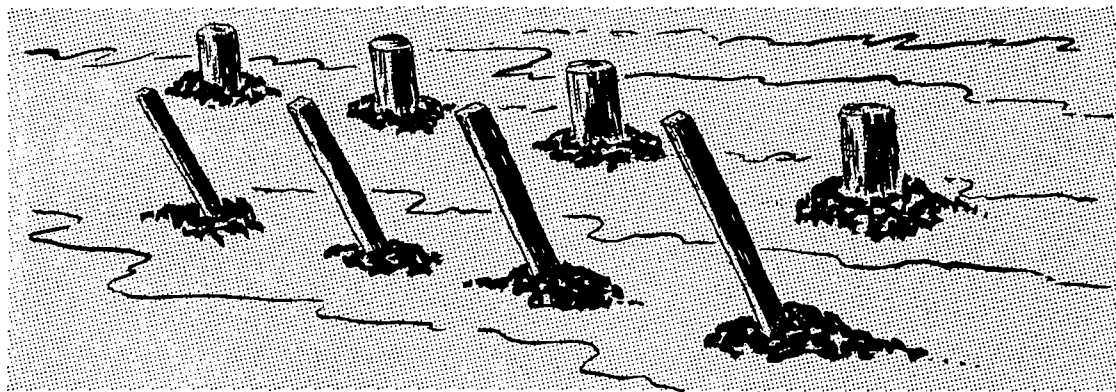


Figure 201. Post lines.

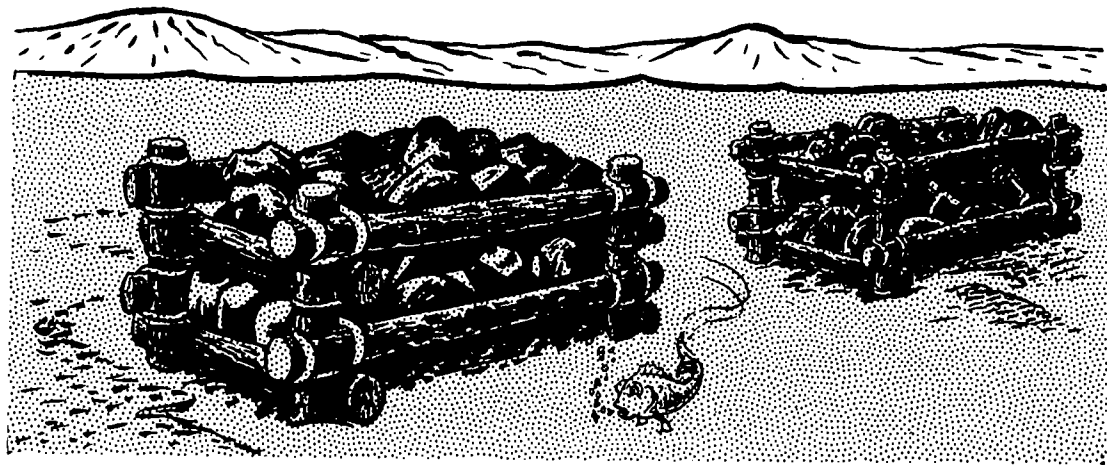


Figure 202. Rock-filled cribs.



Figure 203. Tetrahedra.



Figure 204. Spiders.

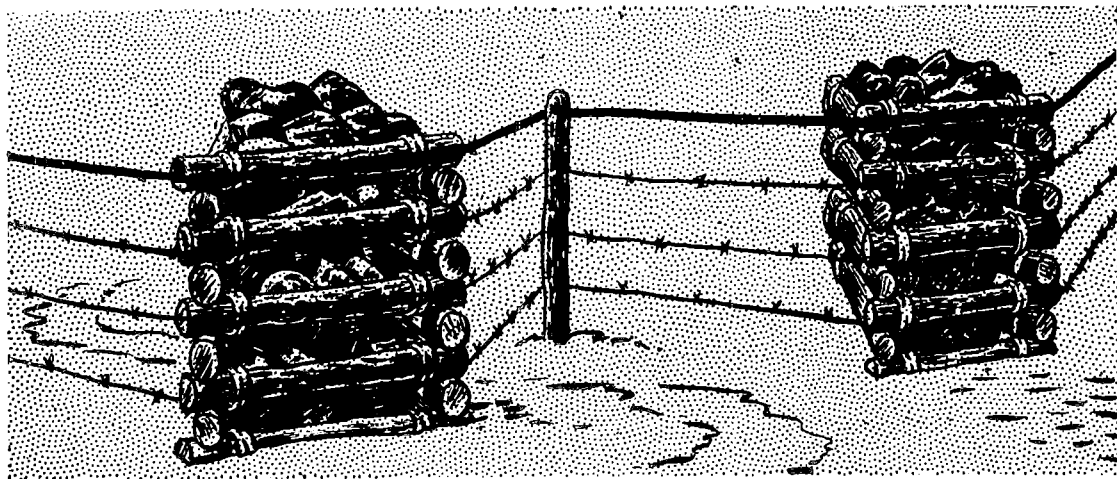


Figure 205. Rock-filled pillars.

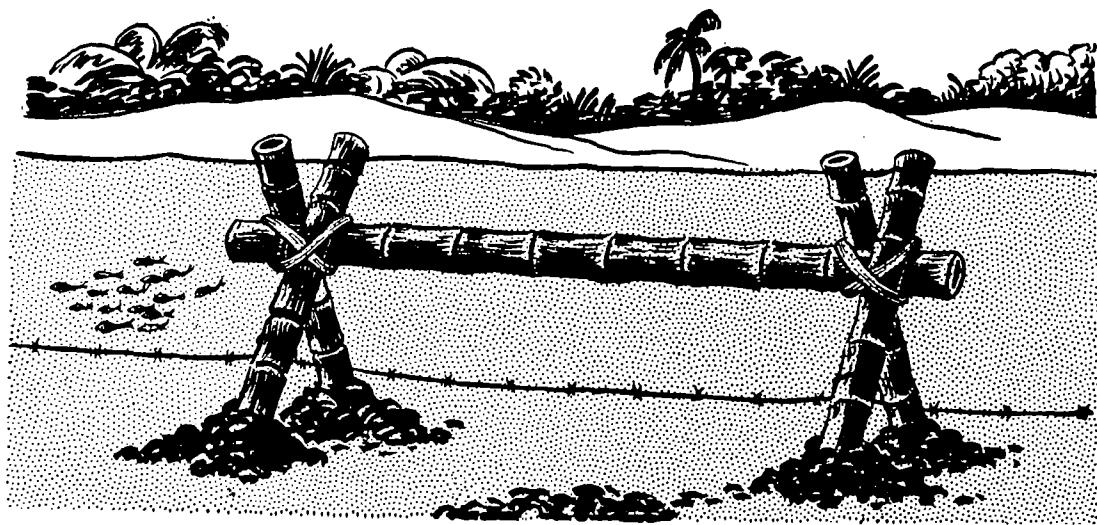


Figure 206. Log barricades.



Figure 207. Rock walls.

APPENDIX I

USE OF EXPLOSIVES IN EXCAVATION OF EMPLACEMENTS

Section I. INTRODUCTION

I. APPLICATION. a. This appendix describes a method of using explosives to reduce the amount of pick work required to excavate gun emplacements, thus making their construction faster and easier. Since blasting craters causes a wide dispersion of soil which is difficult to camouflage, this appendix is concerned chiefly with a procedure for loosening soil with explosives so it can be shoveled easily.

b. The method applies only to types of soil normally excavated with pick and shovel, and not to rock or unusual ground structure. Use of explosives is not recommended for excavations extending less than 2 feet below ground level. The charges used are small, and placed at such depth and spacing that spoil dispersion is confined to a small radius. This confinement is insured by placing a tarpaulin over the tamped charges.

c. The desirability of using explosives as described depends on the availability of explosives and personnel trained in their use, and upon the emplacement's location not being disclosed to the enemy by the sound of explosion.

2. TOOLS AND MATERIALS. Tools required are earth augers, crowbars, pick handles or other tamping sticks, picks, and shovels. Materials required are explosive, electric blasting caps, firing wire, galvanometer, blasting machine, and a tarpaulin or battery, or blasting mat large enough to extend 4 feet beyond the edges of the emplacement.

Section II. GENERAL PROCEDURE

3. DEPTH AND SPACING OF BOREHOLES. a. Depth. Boreholes are dug to the depth of the desired floor level. If this depth is greater than 4 feet, the entire area is excavated to a depth of 4 feet, and the procedure is repeated to obtain the desired depth. Boreholes for ramps are dug while the loosened soil is being shoveled from the emplacement. Crowbars often are necessary to loosen the earth so holes can be dug with augers.

b. Spacing. Boreholes are spaced at not more than one and one-half times the depth and, when possible, in such a pattern that they are equidistant from each other. Typical lay-outs are described in sections III and IV, this appendix.

4. PLACING EXPLOSIVE CHARGES. a. Test charge.

(1) Because effectiveness of explosives differs greatly in various soils, and confinement of spoil is desired, the size of charges used is determined from a test shot. For this shot, $\frac{1}{2}$ pound of explosive per foot of depth is placed in one of the interior holes. The hole is filled, thoroughly tamped, covered with the tarpaulin, and fired electrically.

(2) A complete breaking and loosening of the soil

halfway to adjoining holes, without dispersion of the spoil, is desired. Unless the test results are entirely unsatisfactory, additional test shots are not needed. The results of the test give the basis for determining the quantity of explosive desired for the other holes. Usually, the original charge need not be increased or decreased by more than one half-pound block of explosive.

b. Main charge. The proper amount of explosive, as determined in **a** above, is placed and tamped in each hole, and the cap wires are connected in series. Detonating cord is not used because of resulting damage to the tarpaulin. The tarpaulin is spread and the charges are exploded electrically. If charges are of proper strength, the tarpaulin will be lifted a few feet into the air with most of the spoil confined beneath it, and both spoil and canvas will fall back to their original location. Normally, the tarpaulin will not be damaged unless the ground surface contains rocks, or is frozen or otherwise crusted.

5. COMPLETION OF EMPLACEMENT. The loose earth is removed (fig. 208), the hole is shaped by pick and shovel to the desired dimensions, and the spoil is used to form a parapet. The pot holes blown directly beneath the charges are filled and tamped thoroughly. Ramps are constructed as described in section V, this appendix.

Section III. RECTANGULAR EMPLACEMENTS

6. GENERAL. Boreholes for rectangular emplacements are laid out in parallel rows of equally spaced holes (see



Figure 208. Emplacement after excavation of all loose earth.

fig. 209). A row of holes of proper depth is spaced along the sides 2 feet inside the edge of the emplacement. Since the distance between rows should not exceed one and one-half times the depth of holes, one or more additional rows may be required between the outside rows.

7. LAY-OUT OF CHARGES. a. Outer rows. The outer rows of charges are located as follows:

- (1) Mark outline of emplacement on ground, and locate a hole inside each corner 2 feet from both side lines.
- (2) Space additional holes equidistantly along both sides, at distances not exceeding one and one-half times the depth of holes.

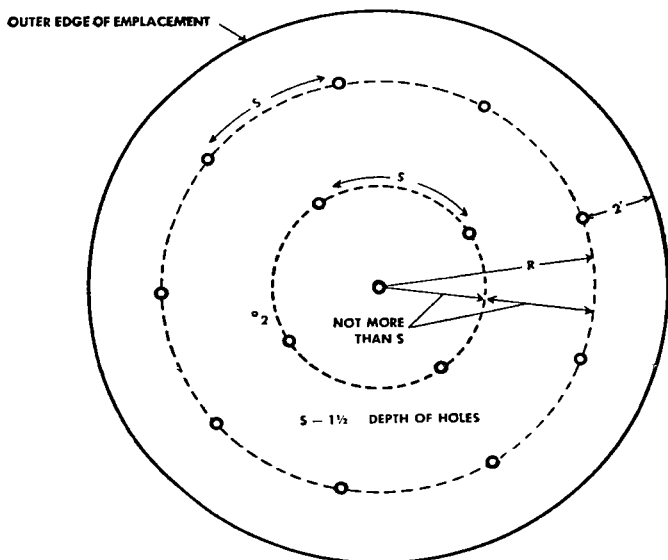


Figure 210. Lay-out of boreholes for large circular emplacements.

charge may be required for small emplacements (fig. 211).

9. LAY-OUT OF CHARGES. Table XVII gives radii of rings and number of holes per ring for circular emplacements of various sizes. This table is based on the following steps:

a. Location of rings.

- (1) Using a length of cord, inscribe on the ground a circle 2 feet less in radius than the desired emplacement.
- (2) Divide the above radius by one and one-half

TABLE XVII. Number of Charges Required*

Depth of bore- hole	Ring No. ¹	Radius of Emplacement																									
		3'		4'		5'		6'		7'		8'		9'		10'		11'		12'		13'		14'		15'	
		R ²	N ³	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N
2'	1	1'0"	3	2'0"	5	3'0"	7	4'0"	9	5'0"	11	6'0"	13	7'0"	15	8'0"	17	9'0"	19	10'0"	21	11'0"	24	12'0"	26	13'0"	28
	2							2'0"	5	2'6"	6	3'0"	7	4'8"	10	5'4"	12	6'0"	13	7'6"	16	8'3"	18	9'0"	19	10'6"	22
	3													2'4"	5	2'8"	6	3'0"	7	5'0"	11	5'6"	12	6'0"	13	7'10"	17
	4																			2'6"	6	2'9"	6	3'0"	7	5'3"	11
	5																									2'8"	6
3'	1	1'0"	3	2'0"	3	3'0"	5	4'0"	6	5'0"	7	6'0"	9	7'0"	10	8'0"	12	9'0"	13	10'0"	14	11'0"	16	12'0"	17	13'0"	19
	2									2'6"	4	3'0"	5	3'6"	5	4'0"	6	4'6"	7	6'8"	10	7'4"	11	8'0"	12	8'8"	13
	3																			3'4"	5	3'8"	6	4'0"	6	4'4"	7
4'	1			2'0"	3	3'0"	4	4'0"	5	5'0"	6	6'0"	7	7'0"	8	8'0"	9	9'0"	10	10'0"	11	11'0"	12	12'0"	13	13'0"	14
	2											3'0"	4	3'6"	4	4'0"	5	4'6"	5	5'0"	6	5'6"	6	6'0"	7	8'8"	10
	3																									4'4"	5

* Number does not include center-hole charge.

¹ Rings are numbered from outside toward center.

²R = Radius of ring of boreholes.

³N = Number of boreholes in ring.

times the depths of holes to determine the number of rings.

- (3) Locate additional rings at equal distances between the outer ring and the center of the ring.

b. Location of holes. Space holes equidistantly along each circumference at distances not exceeding one and one-half times the depth of holes.

c. Small emplacements.

- (1) When the diameter does not exceed one and one-half times the depth, a single charge placed at the center is sufficient. In this emplacement, size of charge is based upon diameter rather than depth of borehole. For a test hole use $\frac{1}{2}$ pound of explosive per $1\frac{1}{2}$ feet of diameter.
- (2) When the diameter is between one and one-half and three times the depth, three holes are spaced equidistantly around the ring and the center hole is omitted (fig. 211).

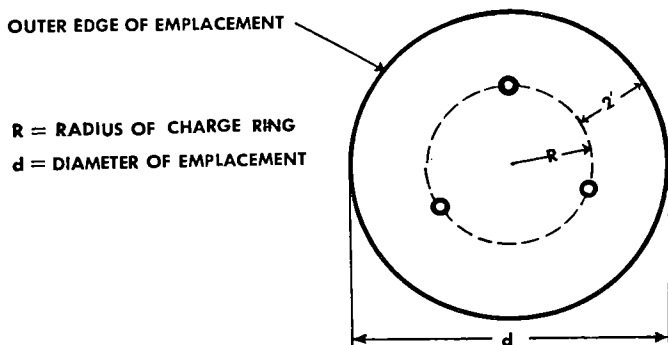


Figure 211. Lay-out of boreholes when diameter of emplacement exceeds one and one-half but not more than three times the depth of the boreholes.

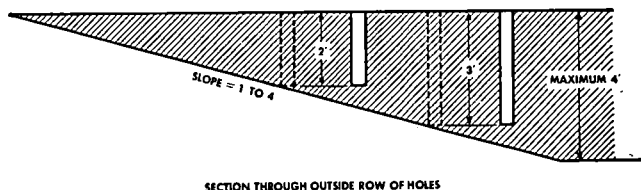
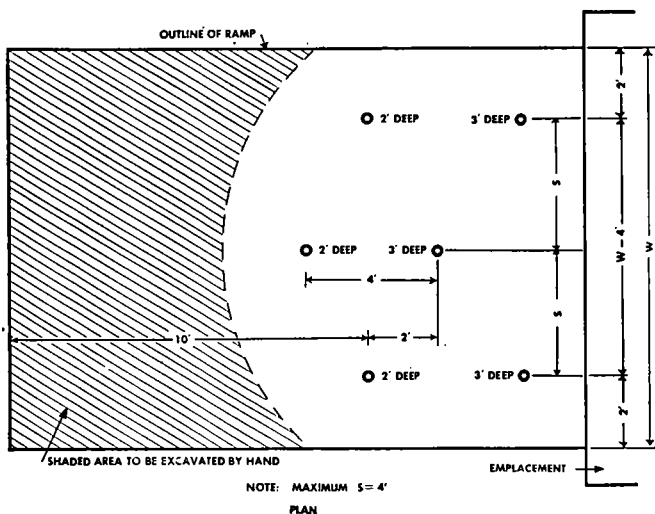


Figure 212, Lay-out of boreholes in preparing a ramp.

Section V. RAMPS

10. GENERAL. Ramps for emplacements are built on a slope of 1 to 4; hence, the length of the ramp depends on the depth of the excavation. Holes increasing in depth down the ramp are laid out as illustrated in figure 212. Since no explosive is used in excavation less than 2 feet, the upper end of the ramp is excavated by pick and shovel. When ramps reaching a depth greater than

4 feet are to be constructed, the portion to be greater than 4 feet deep is excavated by the method used for rectangular emplacements, then sloped as described in paragraph 11, this appendix.

11. LAY-OUT OF CHARGES FOR RAMPS. a. Outside rows. Boreholes are located in the position and to the depth indicated in figure 212. Lay out these holes as follows :

- (1) Trace an outline of the ramp on the ground, with 4 feet of length for every foot of depth.
- (2) Two feet inside the edge of the ramp and 10 feet from its outer end, place a borehole 2 feet deep. In line, 4 feet nearer the emplacement, place a second hole 3 feet deep.
- (3) Place a similar pair of charges 2 feet inside the opposite edge of the ramp.

b. Inner rows. Space inner rows equidistantly between outer rows at distances not exceeding 4 feet. Holes in inner rows have the depths and locations shown in figure 212.

Section VI. CRATERS

12. BLASTING CRATERS FOR EMPLACEMENTS.

When camouflage is not required, craters approximately the desired shape of the emplacement may be blown with explosives. The shovel work required to complete the excavation is considerably less than that required for the method described in preceding sections. The center of the crater will be too deep and must be filled with spoil from the sides and tamped.

13. LAY-OUT OF CHARGES. The lay-out of holes for both circular and rectangular craters is similar to that used in the methods described in sections III and IV, this appendix, except that the following general rules govern the dimensions:

a. The depth of boreholes is two-thirds the desired depth of excavation.

b. Maximum spacing between rows, and between holes in the same row, is twice the depth of boreholes.

c. The distance between the desired boundary of emplacement and outer boreholes is equal to the depth of boreholes.

d. Two-thirds of the charge is placed at the bottom of the borehole, and one-third is placed halfway down.

e. Charges in the center hole of a circular emplacement, and in interior holes of a rectangular emplacement, are twice those used in outer boreholes.

f. Table XVIII is a guide in determining proper charges based on sandy-clay soil. If a number of emplacements are to be constructed, it is desirable to use one of them as a test before boreholes of remaining emplacements are charged.

TABLE XVIII. Quantity of Explosive for Blasting Craters

Depth of borehole: (feet)	Half-pound blocks of explosive
2	5
3	10
4	15
5	25

APPENDIX II

EFFECTS OF BOMBS, PROJECTILES, AND ROCKETS

1. GENERAL. Fortifications are designed primarily to withstand effects of bombs, rockets, and projectiles. The degree of protection provided is dependent upon the time, materials, and tools available and the types of bombs, rockets, and projectiles likely to be used. This appendix is a guide to be followed in designing protective walls and covers of fortifications. It describes the effects of various classes of bombs and projectiles, and indicates the thickness of different materials required to protect against these effects. For complete details on protective thicknesses for permanent construction, see TM 5-310.

2. CLASSES OF EFFECTS. The action of bombs, rockets, and projectiles *striking their targets* may be considered under the following:

a. Explosion upon impact. Bombs, projectiles, and rockets that contain explosives and have instantaneous fuzes which explode upon striking any surface. Such devices are used primarily against personnel above ground level. Walls and cover thick enough to resist blast and penetration of fragments give adequate protection.

b. Penetration. Small arms and other direct-fire weapons whose projectiles do not contain an explosive charge depend upon perforation and scabbing for their

effect. The depth of penetration depends upon the material they strike. Adequate protection can be obtained by getting below ground level or behind walls thick enough to resist penetration.

c. Penetration and explosion. Bombs and explosive projectiles equipped with delayed-action fuzes combine the effects of penetration and rupture from explosion. Adequate protection requires cover and walls thick enough to resist penetration plus rupture and floors thick enough to resist rupture.

d. Blast and radiation. See paragraph 4, this appendix.

3. PROTECTIVE THICKNESSES. Protective thickness is that thickness of a material which is required to protect against any or all of the effects described in paragraph 2 above, except 2d, which is treated in paragraph 4, this appendix. The figures given in tables XIX, XX, and XXI are approximations and are not necessarily minimum safe figures. They are based upon empirical formulas checked against such tests as previously were made, and contain a factor of safety large enough to give the indicated protection under ordinary conditions. Figures are given for typical soils and other materials found under field conditions.

4. EFFECTS OF ATOMIC EXPLOSION. a. General. Accurate figures on exact thicknesses of various types of materials to use in constructing atomic-proof shelters, and exact depths and types of overhead cover for these shelters below the surface of the ground to protect from atomic explosions, are not available at this time; further study is necessary to determine these facts.

From the field fortification standpoint and as far as the combat soldier is concerned, there is no protection from an atomic attack except the soldiers' proximity to the enemy and the fact that such an attack would endanger the enemy's own troops. Protection from atomic attack is primarily a concern of rear area and zone of interior commanders. The following information is included, however, to give an idea of the effects of an atomic explosion.

b. Effects of an atomic explosion. To take the maximum advantage of the terrific destructive effect of an exploding atomic bomb, these bombs normally are exploded well up in the air when their targets are ground installations. The damage resulting from an atomic explosion is effected by three main causes :

- (1) *Blast.* The blast or pressure resulting from the explosion of an atomic bomb is about 20,000 times more powerful and destructive than that resulting from an equal amount of TNT. The initial blast or outward pressure of an atomic explosion lasts much longer than the explosion of TNT and has the effect of a giant hand pushing with terrific pressure. A TNT blast is short and sharp, like a slap, not a push. This blast effect is the major cause of damage to buildings and other structures, but not necessarily to persons or animals. A secondary cause of damage to buildings and structures is by fires started either by heat radiation or through the collapse of buildings, wiring, etc.
- (2) *Radiation.* An atomic explosion gives off immense amounts of radiation of two types, in-

TABLE XIX. Required Thickness in Feet of Overhead Cover for Protection Against Penetration Plus Explosion

Protective material	High explosive shell			General purpose bombs			Rocket
	75-mm	105-mm	155-mm	100-pound	250-pound	500-pound	7.2-in
Reinforced concrete (4,000 pounds/square in.) ..	1	2½	3½	4	5	7	5
Stone masonry or plain concrete.....	1½	3½	5	6	8	9½	8
Logs, 8-inch minimum diameter wired.....	2	5	7	7	9	12	
Crushed stone.....	3½	8½	11	9	12	16	
Tamped earth.....	7	18	25	20	27	40	

Note—Protective thickness given is for a single hit only.

TABLE XX. Thickness Required for Protection Against Single Shots by Direct-Fire Weapons

Materials	Small-arms and MG (7.92-mm) fire at 100 yds ¹	AT rifle (7.92-mm) fire at 100 yards ¹	20-mm AT fire at 200 yards	37-mm AT fire at 400 yards	50-mm AT fire at 400 yards	75-mm direct fire 500-1,000 yards	88-mm direct fire 500-1,000 yards	7.2-in. T-37 rocket	Remarks
Solid walls ² :									
Brick masonry.....feet.....	1½	2	2½	5	-----	-----	-----	-----	Ordinary concrete walls. Structurally reinforced.
Concrete (not reinforced) ³do.....	1	1½	2	3½	4	4½	6½	-----	
Concrete (reinforced) ³do.....	½	1	1½	3	3½	4	5	5	
Stone masonry.....do.....	1	1½	2½	3½	4½	5	-----	-----	These figures can be taken as guide only.
Wood.....do.....	2	3	4	-----	-----	-----	-----	-----	
Timber.....do.....	3	5	-----	-----	-----	-----	-----	-----	
Walls of loose materials packed between loads ² :									
Brick rubble.....feet.....	1	2	2½	5	6	-----	-----	-----	Add 100 percent if wet. Add 50 percent if wet.
Clay (dry).....do.....	3	4	-----	-----	-----	-----	-----	-----	
Loam (dry).....do.....	2	3	4	-----	-----	-----	-----	-----	
Gravel, small stones.....do.....	1	2	2½	5	6	-----	-----	-----	Add 100 percent if wet.
Sand (dry).....do.....	1	2	2½	5	6	-----	-----	-----	
Sandbags filled with ⁴ —									
Brick rubble.....inches.....	20	30	30	60	70	-----	-----	-----	Add 100 percent if wet. Add 50 percent if wet.
Clay (dry).....do.....	40	60	-----	-----	-----	-----	-----	-----	
Loam (dry).....do.....	30	50	60	-----	-----	-----	-----	-----	
Gravel, small stones.....do.....	20	30	30	60	70	-----	-----	-----	

Sand (dry).....do.....	20	30	30	60	70	-----	-----	-----	Add 100 percent if wet.
Loose parapets of ¹ —									
Clay.....feet.....	3½	5	-----	-----	-----	-----	-----	-----	Add 100 percent if wet.
Loam.....do.....	3	4	5	-----	-----	-----	-----	-----	Add 50 percent if wet.
Sand.....do.....	2	3	4	-----	-----	-----	-----	-----	Add 100 percent if wet.

¹ One burst of five shots.

² Thickness given to the nearest half foot.

³ For 3,000 pounds per square inch concrete.

⁴ Thickness for walls made of sandbags given in multiples of filled bag widths (10 inches).

Note: Protective thickness given is for a single shot only. Where direct-fire weapons are able to get five or six hits in the same area, the required protective thickness is approximately twice that indicated.

TABLE XXI. Thickness of Materials Required to Protect Against Penetration of Fragments from Projectiles and Bombs Exploding at a Distance of 50 feet.

Material	Thickness Measured in—	High explosive shell and rockets			General-purpose bomb			
		75-mm	105-mm	155-mm	100-pound	250-pound	500-pound	1,000-pound
Solid walls:	Inches							
Brick masonry.....		4	6	8	8	10	13	17
Concrete (plain).....		4	5	6	8	11	15	18
Concrete (reinforced).....		3	4	5	7	9	12	15
Timber.....		8	10	14	15	18	24	30
Walls of loose material packed between boards:								
Brick rubble.....		9	10	12	18	24	28	30
Gravel, small stones.....		9	10	12	18	24	28	30
Earth.....		15	18	24	24	30		
Sandbags filled with ¹ —								
Brick rubble.....		10	10	20	20	20	30	40
Gravel, small stones.....		10	10	20	20	20	30	40
Sand.....		10	10	20	30	30	40	40
Earth.....		20	20	30	30	40	40	50
Parapets of ² —	Feet							
Sand (dry).....		1	1½	2	2	3	3	4
Earth (dry).....		2	3	4	3	4	5	

¹ Figures given in multiples of width or thickness of sandbags.

² Figures given to nearest half foot.

stantaneous and delayed radiation. Most of this radiation may be classed generally as "light" of some wave length, ranging from the so-called heat radiations of very long wave length to the so-called gamma rays which have wave lengths even shorter than the X-rays used in medicine. All of these radiations travel at the speed of light which is 186,000 miles a second. These radiations are intense enough to kill persons at a great distance from the explosion and are the major causes of deaths and injuries, apart from the mechanical injuries caused by falling structures and flying debris.

- (a) *Delayed radiation.* This type of radiation will penetrate earth, concrete, and other types of overhead cover, unless of adequate thickness, causing casualties to personnel who might otherwise have escaped injury from the blast. Delayed radiation, which results from either fission products or induced radioactivity resulting from an atomic explosion, follows the initial flash of intense heat and instantaneous radiation during the first few milliseconds of the explosion.
- (b) *Instantaneous radiation* (heat and light flash). This initial flash of intense heat and electromagnetic radiation occurs in the first few milliseconds of the explosion. This radiation is capable of burning exposed skin at distances up to two miles. It also is capable of igniting inflammable objects, such as

wooden buildings, telephone poles, dry trees, etc., at similar distances.

c. Likely targets for an atomic attack. At the present time and in the foreseeable future, the production of atomic weapons is so complicated and costly that it is unlikely an enemy would expend an atomic missile on any target other than one of tremendous strategic importance. Such targets are industrial centers, troop concentrations, naval anchorages, cities, and concentrated strategic installations. It is relatively safe to assume that troops in contact with the enemy, and areas as far back as corps rear boundaries, are not likely to be subject to an atomic attack because of the danger to an enemy's own combat troops. Therefore, protection from possible atomic attacks is primarily a concern of strategically important rear area and zone of interior installations, and beyond the scope of this manual.

APPENDIX III

REFERENCES

I. FIELD AND TECHNICAL MANUALS.

FM 5-6, Operations of Engineer Units.

FM 5-20 series, Camouflage.

FM 5-25, Explosives and Demolitions.

FM 5-31, Land Mine Warfare.

TM 3-350, Gasproof Shelters.

TM 5-220, Passage of Obstacles other than Mine Fields.

TM 5-255, Aviation Engineers.

TM 5-267, Camouflage.

TM 5-310, Military Protective Construction.

2. TRAINING AIDS.

TF 5-1226, The Double Apron Fence.

TF 7-993, Infantry Hasty Field Fortifications—Part I
—Individual Entrenchments.

TF 7-1131, Infantry Hasty Field Fortifications—Part
II—Emplacement of the Light and Heavy Cal. .30
Machine Guns.

TF 7-1182, The Rifle Squad and Platoon in Defense—
Part I—Intrenchments of the Rifle Squad.

FB 220, Arctic Igloo.

GTA 5-9, Barbed-wire Obstacle.

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